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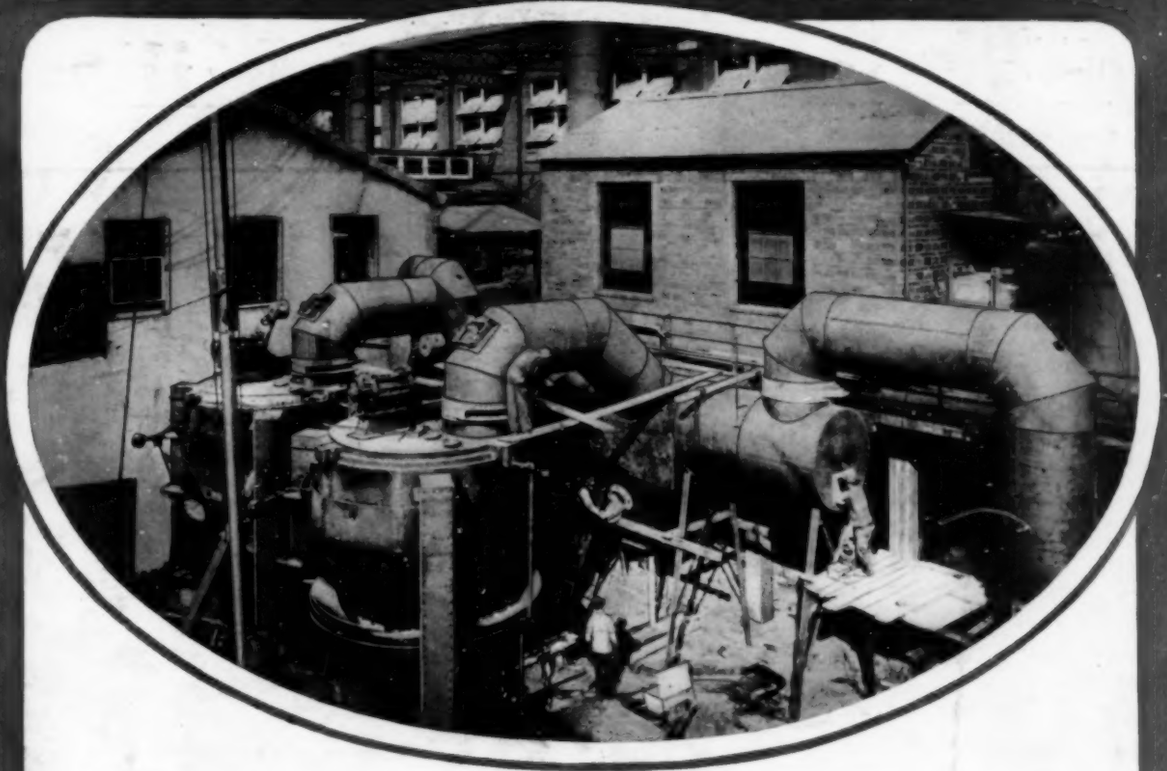

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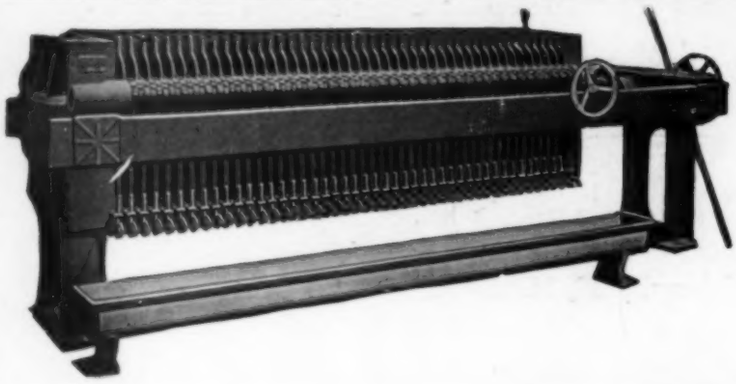

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A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE
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Volume 26 — New York, February 22, 1922 — Number 8

The Trade Association's Relation to Industry

WHILE the announcement of the government's attitude toward the trade association leaves much to be desired, it is nevertheless a distinctly forward step in our industrial program. It relieves business to a great extent of the burden of uncertainty which had been heaped upon its shoulders by the Supreme Court decision last December in the case against the Hardwood Lumber Manufacturers' Association. The outcome of that case has affected the whole network of industries, for the open price association or "open competition plan," which it threatened, had become thoroughly established in many basic industries. Consumers and distributors as well as producers had felt its effect. Now comes the word that the plan, with certain definite limitations and under the very close supervision of the Department of Commerce, can be continued.

Secretary HOOVER, whose recent work with that department has been largely based on the establishment of a comprehensive statistical service as well as an intimate contact with all trade agencies, has endeavored to obtain a public statement from the Department of Justice from which business might derive final and official legal guidance. The fear that such a statement might be used in the courts against the government, however, has no doubt actuated the Attorney-General in his desire to confine his opinion to the form in which it is now made public—namely, as an informal interdepartmental inquiry defining the policy to be pursued by the Commerce Department in its future relations with business.

Of all the many activities of the trade associations, those connected with the statistical services have involved questions of perhaps the most serious and complex legal character. The decision in the case of the hardwood manufacturers, it will be recalled, was not a condemnation of the gathering and dissemination of statistics *per se*, nor did it prevent the recipient from using such statistical information as a basis for his future busness transactions. It is only when the statistics are collected by some centralized authority and so interpreted by him as to evoke or otherwise result in combined action in restricted production, price fixing or some other equally unlawful activity that the government has held the procedure to be in restraint of trade and therefore a violation of the Sherman act. The Secretary put the case well and forcefully when he said, "The fact that the minority may be known to violate given laws does not establish a principle that the primary means, lawful in itself, which they have adopted for the purpose of performing the unlawful acts, should be entirely abolished and its use forbidden to law-abiding citizens." Thus the revolver in the hands of the criminal may be used illegally, but there are many good reasons why the revolver should not be legislated out of existence. The reckless automobile driver is a dangerous law-breaker, but certainly we are not justified in abolishing the automobile simply because he chooses to use it illegally. Those users of the open competition plan who in the past have offended the majesty of the law should be made to suffer, but the plan when properly conducted can be made a legitimate service to business.

The inquiries of Secretary HOOVER, reproduced on another page of this issue, outline a plan by which the Department of Commerce is to become a general clearing house for statistical information from all trade associations. Through him these data are then to be transmitted to the general public. Thus buyer and seller, producer and consumer, receive the same information regarding industrial conditions and are able to base their business judgment on the same facts and figures. Another plan which has received serious consideration in many quarters has been the proposal to use the industrial press as the medium for the dissemination of this information. One of our readers, whose letter we are glad to publish under "Readers' Views and Comments," has outlined a definite form of co-operation between the association secretary and the editor of the business paper. Such an arrangement naturally meets with the approval of the technical magazine interested in furthering the best interests of the industry it serves.

There can be no question about the legality of many of the activities which are discussed in the Hoover-Daugherty correspondence. The value of constructive endeavor such as the handling of educational and welfare work, the elimination of wasteful practices, co-operative advertising, and strengthening foreign and domestic trade, is not to be questioned. An investigation recently made by the Chamber of Commerce of the United States has resulted in a list of almost eighty different activities which in the past have absorbed the attention of the various trade and business organizations. Some of these, to be sure, have been discontinued because of the decision, but undoubtedly there are many ways in which associations can benefit industry.

The chief good arising from the government's statement is the official recognition of the trade association as an essential element of modern business. We can now be sure that we are not going to revert to the days when business was characterized by ignorant, wasteful competition, price cutting, over- and underproduction, and periodic labor shortages followed by unemployment. The officers and members of trade associations must see that illegal practices are abolished and must do their share in dispelling the suspicion that has surrounded their activities. And, finally, by accepting the government's offer of co-operation, they can pave the way to a better and more intelligent service to industry and to the general public.

When Does an Employment Contract Terminate?

HOW much of a man's brain does the law allow him enforceably to sign away through the necessities of making a living? How far do enactments against peonage protect a technical man from the operation of contracts terminable at the will of his employer, but with provisions stipulating duties after termination?

The questions above have an added pertinence today when so many technically trained men, precipitately let go during the past year at the first pinch of adversity, are now put to the necessity of bargaining their training and intelligence for the means of a living. Old contracts that meant bread and butter yesterday may be the means of denying it today—at least in the profession chosen. A man's experience and training in this world, barring the possession of wealth, are the capital whereon he must seek returns for a livelihood. The practice of some large technical corporations which extort, as the price of employment, the signing of a contract forever limiting a man's usefulness outside their own factory walls is open to serious discussion in the light of present conditions. Some protection is undoubtedly due the employer of confidential technicians who labor and create for the advantage of that employer; but should that protection be given gratis or exacted as the price of a job? If it is of value should it not be paid for, either by some assurance of stability of position or, at least, by some more valuable consideration than a month's notice?

Incidents such as a recent one wherein a large corporation has sought by the threat of legal prosecution to prevent a research engineer, formerly in its employ and recently released for economy's sake, from following his calling in his own chosen field demand attention that will forever prevent a repetition of the attempt. In the instance cited a signed contract is now invoked and exhibited which, strictly interpreted, would make the effort successful. Just how binding are unjust provisions of an employment contract? An executed instrument that specifies duties after employment has ceased may be the means of blacklist and boycott, unless the unfortunate signer seeks a different field. Unfitted, possibly, for anything else; his whole life training rendered useless; a corporation that battens on brains can tell him he may starve—if that is the only alternative.

The average man in need of employment is in no position to dictate or object to terms in the contract offered him. In a sense he is coerced by circumstances into signing, and the measure of his necessity is the degree of coercion practiced. Just how binding, morally or legally, is an instrument in which the element of coercion enters?

But a contract must allow the right to discharge. In technical employment, if the employee is guilty of violating the confidence reposed in him, the right to discharge is not sufficient. It should be strengthened, and by mutual recognition, by the assurance of prosecution and punishment. Where no culpability enters in, however, a mutual agreement should proclaim and recognize a mutual responsibility. Necessities which lead to severing the ties of such an agreement should terminate the responsibility as well. When released through no fault of their own, technical men should be protected from every danger of blacklist, boycott or attempted curtailment of their usefulness to themselves or society through the operation of contracts signed while seeking employment. A court precedent should establish that a contract terminated in one particular is thereby terminated in every other.

Are there other injuries being worked today through hold-over duties and obligations of terminated contracts? A federal investigation of the employment contracts offered technical men by those corporations entering into interstate commerce might throw interesting light on the subject.

Information for Business Guidance

A FRIEND of ours raises the question whether the average business man who directs the affairs of commercial enterprises has a clear concept of all the information necessary for guidance in making business decisions. He doubts not that business men, as a rule, gather a vast amount of information, but he has serious misgivings as to whether they recognize the essentials and do not burden and confuse their minds with matters that have no real bearing on their problems.

We know quite well that the typical business man is strong on efficiency. He is great for requiring his superintendents and foremen to introduce efficient methods in the factory. He seeks efficiency in the physical manipulation of his affairs, requiring, for instance, that the papers coming to his desk be placed on a certain spot, and providing a series of baskets for the outgoing stuff. Nothing must come to his desk that does not belong there. The underling is reprimanded if he brings something to him that should be handled by SMITH or JONES, and is reprimanded likewise if he places before SMITH or JONES a matter that should be settled by the boss himself.

It is a question of efficiency in mental operations. Does our business man take equal pains to see that information essential to good business judgment is placed in an orderly manner in his mind, while unnecessary matters are kept out so that they do not clutter his mental desk? That is quite doubtful. Men of affairs are often moved by example rather than by study of underlying conditions. The point is well illustrated by boards of directors. There are directors who might perhaps be called peripatetic for want of a better term. They belong to numerous boards. When they see a certain action taken at one board meeting, whether in the direction of retrenchment or expansion, they are likely to favor similar action at the meeting of the next corporation whose fortunes they help to direct, and by and by things are going again or stopped again as the case may be.

A crucial test is now being made that will show whether business men really seek and use the kind of information that should guide them in the conduct of business. Under the direction of Secretary HOOVER the Department of Commerce has undertaken to publish in compact and simple form all the pertinent facts that can be gathered as to business trends and conditions. The reports have been issued for some time and are being improved and extended as opportunity affords. The reaction of the business world to these publications is now awaited. The plan is well conceived. The information is not complete, but it is so much more comprehensive than the information the individual has hitherto been able to get that it greatly increases his field of knowledge. What is the reaction in the chemical and related industries to the *Survey of Current Business?* We shall be glad to receive expressions of opinion either for personal information or for publication.

Use of Graphs In Plant Operation

SCIENTIFIC men and technologists are cognizant of the great value attached to the use of the graph in visualizing figures, since it is one of the basic studies in technical curricula. Relatively few of these men promoted to responsible charge of plants have thought to apply the graph to the everyday details of plant management and control.

Study of an article presented on another page under the heading "Graphic Record of Sulphuric-Acid Plant Operation" should open up a line of thought which may well lead to the education of superintendents and foremen in the use of the graph and its subsequent installation as part of the daily record.

Certainly the average individual engaged in running the process has a native intelligence enabling him to grasp the meaning and application of the ordinary chart.

Graph usage is simple and should be made a tool of the operator as well as the student.

Chemical Storage Of Power

THE discussion of Muscle Shoals as a power project and broad industrial chemical opportunity has developed a thought rather new to chemical engineers—namely, that the storage of power in peak flow periods should be done by chemical means. This idea certainly has interesting possibilities, and these should receive careful study on the basis of engineering facts, for if the opportunity really exists which some credit to this scheme, it will mean marvelous new things in many localities.

The Tennessee River at low water could produce relatively little power (estimated for Dam No. 2 at less than 50,000 hp.) as compared with the maximum at flood periods which would supply well up into the millions of horsepower if all the water power could be utilized. Obviously investment for the period of maximum water flow is altogether out of the question. Also a minimum power development of 50,000 hp. would be inefficiently low. Therefore by storage of water it is possible to insure substantially 100,000 hp. continuously through 12 months, considering the Wilson dam alone. By storage in suitable impounding reservoirs on the upper river or by installation of other power dams above the No. 2 or Wilson dam, the flow would be still further regulated and a continuous horsepower correspondingly higher would be available.

At Dam No. 2 it is proposed that the installed horsepower be 600,000. Probably 250,000 hp. can be made continuously available at this point by supplementing the power from the dam during periods of low water with steam power from the plants connected with Nitrate Plant No. 2. However, it is reported that Mr. FORD intends still further to supplement power for continuous processing throughout the year by a third means, which might well be called the "chemical" storage of power.

One proposal is that during periods of high water some of the electrical energy be used for making metallic sodium. This metallic sodium would then be put in storage under oil to be used as a reagent during periods of low water flow. As such reagent, it would enable an operator to carry out processes of high energy demand such as the manufacture of aluminum, magnesium or other similar light metals from their oxides. Thus a chemical process would be substituted at low water periods for an electrochemical method which doubtless would prevail during periods of maximum power.

At first thought it does not appear that the investment necessary for this manufacture and storage of sodium would be as economical as corresponding investment in storage dams on the upper river, which would permit uniform delivery of power from the Wilson dam because of uniform flow of water. However, it would be imprudent to draw any such conclusion without a very careful electrical and chemical study of the problem from an engineering point of view. Things quite as novel as the use of sodium for a reagent have been made successful in times past and if this proposal proves to have substantial foundation in engineering fact, it will contribute much to the success not only of Muscle Shoals but also of other developments where irregular runoff results in large seasonal fluctuation in power.

Green Fields and Pastures New

DR. LOUIS BERMAN, who is an associate in biological chemistry at Columbia University, has written a book on the "Glands Regulating Personality," which some day we may review at length. In the meantime it points to the gate of one of the most fascinating but involved and as yet untilled fields of organic chemistry. By merely glancing in, however, we find almost irresistible invitations for research.

These ductless glands in every one of us are substantially the same—but only substantially so. They differ in particular, just as our fingerprints differ. And so their products, which are substantially the same, differ in mass and in mixture. These products are carried in the blood and delivered where they are needed. The secretions are called hormones, which indicates that they arouse or set in motion; and it has been said of them that they are "chemical messengers, sent from one organ to another through the public highway, which is the blood." Again, the stream of blood has been likened to a moving platform on which the various hormones embark and from which they alight where the signal or a field of force attracts them, or where a barrier opposes their further progress.

Still greatly to be studied are the functions of the hormones or secretions from ductless glands. The glands are located all over the body—in the head, in the throat, in the chest, on the kidneys and in the abdomen. Some stimulus excites a gland to activity and soon its secretion is at work, arousing curiosity or fear or anger or affection. These emotions are chemical!

If study goes far enough in this subject, it may throw great light on the treatment of insanity, for it stands to reason that with many sufferers it is the excess of some particular emotion, due to a gland working only a little out of its proper proportion, that causes all the trouble. Only lately at Sing Sing prison an operation was performed along these lines on a habitual criminal, by transplanting glandular tissue from an executed man into him. He shows signs of becoming normal under the better balance of hormones, but of course some cheerful idiot whose glandular secretions have mixed themselves up into soup claimed to have discovered that a law forbids any such "interference" with what is blasphemously called "the work of GOD."

When blood analysis shows what hormones are lacking and what are in excess, and when enzymes are so understood that we shall know the stimulus for each ductless gland, there may be far less misery in the world.

Readers' Views and Comments

Trade Association Activities and the Industrial Press

To the Editor of Chemical & Metallurgical Engineering

SIR:—As you pointed out in an editorial a few weeks ago, the activities of trade associations are now limited as a result of the decision of the United States Supreme Court in the case of the American Hardwood Manufacturers' Association. It appears that the maintenance of open-price information must be discontinued unless such information can be supplied by some means other than through the confidential reports of the trade association secretaries.

Doesn't this condition offer an unusual opportunity for co-operation between the trade associations and the industrial press? The industrial journals now carry, in addition to the purely technical information, price lists, condensed financial statements of the leading companies, discussions of employment problems, etc. Is it not a logical step forward for them to print production figures, sales statistics, average costs and other data now collected by the secretaries of the various trade associations? Let the trade association secretary be given a page or two for the presentation of his statistics in one or more of the leading industrial or technical journals serving his particular industry. The secretary should have no connection with the editorial staff of the journal. He should present his data without comment or discussion and his contributions should be printed as so much current industrial news. The editors of the magazine, however, would have a perfect right to comment on the data presented and to interpret them for the good of the industry.

In the Hardwood Manufacturers decision the Supreme Court commented on the association's "plan" of daily, weekly and monthly reports as follows:

> It is futile to argue that the purpose of the "plan" was simply to furnish those engaged in this industry the equivalent of such information as is contained in the newspapers and government publications with respect to the market for commodities sold on boards of trade or stock exchanges. One distinguishing and sufficient difference is that the published reports go to both seller and buyer, but these reports go to the seller only; and another is that there is no skilled interpreter of the published reports, such as we have in this case, to insistently recommend harmony of action likely to prove profitable in proportion as it is unitedly pursued.

The presentation of these trade statistics in an industrial journal would make them available to both buyer and seller, and therefore no legal complications should be produced. In this connection Gilbert H. Montague of the New York bar has made the following illuminating statement:[1]

> It is clear that comment and advice based upon trade statistics is dangerous when indulged in by the trade associations themselves, yet the same advice and comment may be quite harmless when given independently by a publication that is not a member of the association and which is accessible to buyer and seller alike. The editor of a trade publication can usually make such comment as he pleases for the benefit of the industry as a whole, and a discussion of demand and production which would bring down the whole force of the Department of Justice if emanating from a trade association secretary might be wholly innocent if published independently in the editorial columns of a trade or technical publication.

The average progressive manufacturer has come to see the advantages of the trade association and he appreciates the benefits of membership in it. He does, however, guard very carefully what he considers the vital statistics of his particular business. He probably would hesitate to send in his sales figures, costs, etc., to the assistant editor of an industrial magazine. He might also be opposed to sending such data to some unknown clerk in the Department of Commerce or to any other government agency. But the secretary of the trade association is in a different position. The manufacturer has a voice in appointing him and he pays a part of his salary. He has confidence in him. He knows that the data concerning his own business will go only to the secretary, and that they will be averaged or totaled with the corresponding data of his competitors. It seems likely, therefore, that the publication of these statistics under the conditions outlined above would receive the support of the manufacturers. Why doesn't the Synthetic Organic Chemical Manufacturers' Association try it?

I. E. KNAPP.
Jackson Laboratory,
E. I. du Pont de Nemours & Co.,
Carneys Point, N. J.

[1] *Printers' Ink*, Jan. 19, 1922, p. 62.

The Manhood of Humanity

To the Editor of Chemical & Metallurgical Engineering

SIR:—In your issue of Jan. 4 is a long review by Ellwood Hendrick of Count Korzybski's "The Manhood of Humanity; the Science and Art of Human Engineering." Mr. Hendrick spoke favorably of the book and seemed impressed by its arguments. Having a respect for Mr. Hendrick's opinions, I was surprised that he took the book so seriously, just as I had been surprised that Prof. Keyser of Columbia University recently devoted a laudatory address to it. When I tried to read the book and comprehend the valuable theories it was said to contain, I concluded either that the book had been grossly overpraised or that I am especially dense at understanding such things. Today I noticed an unfavorable review of the book by Robert H. Lowie in *The New Republic* of Feb. 8, and it seems to me that his condemnations are justified. He points out that the so-called epoch-making discovery of man as a "time-binder" is not new at all; that the mathematical basis of the theory is inconsequential; and that the naïve assumption that human nature will reform itself when thus shown the mathematical error of its ways is laughable. With all respect to Mr. Hendrick, Prof. Keyser and the others who have praised the book, I agree with Mr. Lowie that Count Korzybski's solution of "human engineering" is not worth reading or thinking about.

New York University. P. B. MCDONALD.

Some New Petroleum Products

In the article, "Some New Petroleum Products," by J. H. James, published in our issue of Feb. 1, 1922, the lines at the top of page 212 should read "Rate of water feed to vaporizer, 0.6 liter per hour" instead of "6 liters per hour" as erroneously printed.

When Does an Employment Contract Terminate?

To the Editor of Chemical & Metallurgical Engineering

SIR:—There is an element of truth in the editorial, "When Does an Employment Contract Terminate?" which you have sent to me for my comment. The difficulty exists more in a system that permits the wrongs as suggested, and more with greedy and unscrupulous officials of corporations and others, than with laws failing to protect professional men. As is suggested, court precedents may be needed more fully to safeguard their interests, since the law is a growing thing capable of being adapted to new conditions. Perhaps with the development of our modern industrialism with its innumerable ramifications and requirements for its own existence, as where it depends on secret processes, conditions surrounding employment contracts may demand court rulings, at least as to what would be presumed to be against public policy in such contracts. But here immediately we get into deep water.

One may imagine a case where a professional chemist is engaged in a factory founded on a secret process and bound by contract to keep the secret. He may give up the pursuit of all other lines so long that his usefulness in any other field or factory is permanently impaired. Yet he may be let out of his employment and by his agreement be restrained from engaging in the work he best knows or from imparting the information gained in the specialized line. Can we justly say that this is the fault of law or of our system, and if the fault of either, may it be corrected by statute or court decisions?

The right to contract for one's services is part of that pursuit of life, liberty and happiness proclaimed in the Declaration of Independence and guaranteed by the Constitution. To restrict the right to contract fully encroaches on this right, which inures to the benefit of both parties to the agreement. The right to break a contract is also a fundamental right. Nor may a court require one to perform a contract where it is for personal services, but a court of equity may restrain one from rendering like services to others under certain limitations.

In leaving open the right to contract freely, equity will protect the parties against fraud, coercion and undue influence as far as that is possible and where proper will relieve against such wrongs. If through stress of circumstances and conditions a person is unduly influenced to enter into a contract of service to his damage, equity will relieve him.

Peonage is involuntary servitude and is not permitted under our laws. One may contract to render service in payment of an obligation, but he may leave his employment at any time he chooses. No law or court may force him to render the service agreed upon. By contract one may be restricted in his field of operation or work, but it is against public policy for one to agree wholly to refrain from following a vocation, going into business, etc. One may not bargain away his right to earn his living. In theory at least he may not bargain away his ability or diminish his ability to earn a living. Such would be against public policy, and any contract based thereon would be unenforceable. Should an employer know that his employee was in necessitous circumstances influencing his entering into a contract, and such employer took advantage of these facts to the detriment of the employee, equity would relieve the employee and discharge the contract. Obviously charging the employer with such knowledge is difficult to prove, since the employee studiously endeavors to hide his necessitous condition. We regard it good business as well as perfectly permissible for an employer to attempt to keep secret his secret processes, to keep specialized knowledge and discoveries from his competitors, and therefore to put provisions in the employment contract requiring the employee not to disclose information or not to engage with competitors, and the like. It is doubtful if such contracts can be enforced, at least in such a manner as to protect the employer as he intends.

If large technical corporations extort, as the price of employment, contracts from their employees forever limiting a man's usefulness outside their own factory walls, the writer is of opinion that such contracts are unenforceable and valueless to the employer except to "scare" the employee. Of course, the corporation with its money has the advantage in being able to litigate, and such might in many instances result in a denial of justice to one unable to litigate. Because of this denial of justice a federal investigation might be a worthy thing, as suggested, though a relieving statute might not and probably would not be deemed advisable.

No contract is binding on the injured party where coercion enters in. But the coercion must come from the other party to the contract. Coercion is the result of fear of some harm from threatened force. Undue influence is the more proper term to be employed in the sense as discussed here. Even undue influence must be used, or advantage taken of one's condition, by the employer party to the contract.

Chicago, Ill. WELLINGTON GUSTIN.

Recent Progress in Electrical Precipitation

To the Editor of Chemical & Metallurgical Engineering

SIR:—I am surprised as well as embarrassed that you have thrust honor upon me for having developed the mathematical equation given in the article by Evald Anderson on "Recent Progress in Electrical Precipitation," CHEMICAL & METALLURGICAL ENGINEERING, Jan. 25, 1922, p. 152. The truth is that I had nothing to do with the development of this equation, which we feel represents a distinct advance in the art, it having been done by A. A. Schmidt, who is in charge of our engineering work. WALTER A. SCHMIDT.

Western Precipitation Co.,
Los Angeles, Cal.

On the Theory of Hardening of Metals

Prof. Honda has called attention to unfortunate errors in his paper published in CHEMICAL & METALLURGICAL ENGINEERING for NOV. 30, 1921 (vol. 25, p. 1003). Conclusions noted under the caption "Results of Investigation of Duralumin" should read:

2. The above effect of quenching is due to the dissolution of copper and magnesium compounds in the aluminum, the process of solution or separation being very slow. Thus duralumin is in a somewhat hardened state even if it is cooled very slowly from 500 deg. C.; a perfect annealing is obtained only by heating the alloy at 350 deg. C. for 1 hour or more.

3. Up to about 6 per cent Cu, alloys of Al and Cu show by quenching an immediate hardening, but very little effect on aging. Hence the immediate hardness is partly due to the dissolution of $CuAl_2$ in Al.

5. The aging after quenching is attributed to the dissolution of Mg_2Si in the $CuAl_2$ solid solution in Al. It is not due to metallic magnesium, because a mere increase of Mg does not result in an increase of aging effect, but an increase of both Mg and Si in the proportion of the compound Mg_2Si magnifies the same effect.

The Chemical Industry of Russia

By V. Leitis

PRIOR to the war, the chemical industry of Russia, and even her chemical trade as well, were in German hands. Every important German chemical concern had its branch in Russia, where—aided by the Russian protective tariff—it prepared fertilizers and all possible drugs and medicines, except the patented ones, which were made in Germany to keep the formulas secret.

German Influence

The Russian educational institutions were not able to develop chemists in sufficient numbers, and many came from Germany. As a result, almost every chemical plant—even the purely Russian ones—and every laboratory in Russia had German chemists. On the other hand, to keep Russians away from German secrets, those Russians who graduated from German chemical schools were not accepted as employees in Germany. The Aktien Gesellschaft für Anilinfabrikation, Badische Anilin- und Soda-fabrik, Farbenfabriken vorm. Friedr. Bayer & Co. were among the leading chemical firms in Russia. In regard to their size, it may be mentioned that in 1913 the Bayer company alone employed about 330 chemists and 280 engineers and mechanics. Under such competition, Russia was not able to develop its own chemical industry. As a result, Russia not only used chemical products made in Russia by Germans, but also imported heavily from Germany. Thus, in 1914 Russia imported from Germany the following quantities of fertilizer materials:

	Tons		Tons
Superphosphates	300,000	Chilean nitrate of soda	48,000
Thomas slag	177,000	Kainite, guano, etc.	32,000
Total			557,000

It should be remembered that Russia is rather rich in phosphates which could be converted into superphosphates. Some Russian factories were engaged in this line, producing about 100,000 tons of superphosphates annually, but they were handicapped by German competition and better German selling methods. Furthermore, they did not enjoy as easy bank credit as the Germans, owing to the great German influence in Russian commercial banks.

The production of soda was entirely in Russian hands (Loobimoff & Co.), likewise a great part of the sulphuric acid industry, although some works located in Riga (present Latvia) which used imported ore were owned by Germans.

Development During Early Part of War

The war stopped the activities of Germans in Russia, the imports ceased, and of necessity Russia was compelled to create a chemical industry of her own. Russian chemists were invited and gradually the industry grew stronger until 1918, when Bolshevists came into power, and by nationalization and other communistic means checked the growth of this young industry.

At the end of 1919, there were in Russia the following chemical works:

	No.		No.
Salt and acid	35	Potash	45
Soda	3	Quicksilver	1
Dyes	3	Mineral wax	1
Compressed gas	14	Phosphates	9
Prussiate	2		
Total			113

All these plants were of small size, their equipment being antiquated, worn out and broken to such a degree that the Bolshevists could put into operation only eighteen of them, employing 7,225 workmen.

The output of these plants in 1920 to 1921 was extremely low when compared with pre-war figures, as shown in Table I.

TABLE I—PRODUCTION OF CHEMICALS IN RUSSIA

Products	1920, Tons	1921, 6 Months, Tons	1913, Tons
Sulphuric acid	13,827	1,287	200,000
Oleum	4,845	..	10,970
Nitric acid	430	66	24,355
Hydrochloric acid	15,843	33	65,483
Copper sulphate	91	114	No figures at hand
Superphosphates	5,833	..	100,000
Bichromate of ammonia	58	22	No figures at hand
Salts:			
Sulphate	14,013	..	.....
Chlorate	292	..	.....
Carbonate	11,050	..	.....
Chromates	1,110	..	.....
Sodium sulphite	807	..	.....
Bleaching powder	3,000	..	.....
Other salts products	850	..	.....
Total	72,049	1,522	

Effects of Bolshevist Rule

The present inefficiency of the Russian chemical industry can be explained by the communistic régime: crippled transportation, inefficient management, underfed and underpaid workers, lack of fuel and raw material. To be progressive, this industry needs the cooperation of scientists, and if we examine the conditions in Russia we shall find everything there in favor of the uneducated man, with nothing for the intellectual class. The "intelligentia" has been pursued and despised by the Bolshevists and rule of the uneducated class has been established. The intellectual class was driven to compulsory physical work, street cleaning, wood cutting, even work in coal mines, but the scientific work could not be made compulsory. It was a highly mistaken idea to imagine that the proletariat alone would be able to manage the business of the state, putting the intellectual class aside. Since 1919, the Bolshevists have tried to remedy this fault by granting some privileges to the scientific and intellectual professions, but unfortunately too late—the country has already been ruined.

The harm done to agriculture is readily appreciated if we consider the total production and import of fertilizers in pre-war times (over 700,000 tons) and compare this figure with the 5,833 tons produced in 1920 (there was no import of fertilizers because of lack of money). In 1921 no fertilizers were produced.

For the production of dyes, 325 workers were employed, and the output, according to Bolshevist reports, was sufficient to supply only the needs of the state printery, where the Bolshevist paper money was printed.

The same condition affected the production of drugs and pharmaceuticals. In 1919-20, the thirty-two existing drug factories employed only 1,551 operators, the output being as follows:

	1913, Kg.	1919, Kg.	1920, Kg.
Chemical preparations	2,000,000	75,117	71,576
Drugs	3,000,000	283,264	401,176
Disinfectants	1,000,000	.....	226,529
Total	6,000,000	368,381	699,281

Regarding the future of the Russian chemical industry, foreign influence will undoubtedly prevail. If anything is being produced at the present time, it is done so regardless of cost, since payment is made with the worthless Bolshevist paper money under the management of the state. Such a situation cannot last indefinitely.

Riga, Latvia.

Grain Growth and Recrystallization in Metals. I—Definitions

Technical Definition of Recrystallization, and a List of Recrystallization Temperatures for Common Metals—Various Methods for Measuring Grain Size, Shape and Volume—Elongated Grains May Not Always Contain Strained Metal, Even When Apparently Stable

BY ZAY JEFFRIES AND R. S. ARCHER
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CRYSTALLINE structure of metals was discussed in a previous article.[1] The present articles will deal more specifically with the sizes and shapes of grains produced on the solidification of metals, on grain growth in the solid state and on recrystallization.

When a metal freezes the sizes and shapes of the crystalline units or grains vary in accordance with the conditions obtaining at the time of crystallization. In general there is no distinction made between crystallization and solidification, since the latter is due to the former. As a rule rapid solidification produces smaller grains than slow solidification. The grain size of cast metals, provided they have not been plastically deformed, cannot be changed by heating below the melting point. This is true no matter what the grain size in the cast metal.[2] When a cast metal is plastically deformed at a temperature high enough so that no "strain hardening" results, microscopic examination shows that new and usually smaller grains have been produced. Working a metal at such temperatures is termed "hot-working." Plastic deformation has thus caused the grains to undergo some change which usually produces several grains from each of the original ones. Supposing the metal under consideration is copper and assuming that the temperature of working is 600 deg. C., severe working will produce a marked "refining" of the structure—that is, the grains will have increased greatly in number and will have decreased proportionately in size. If the metal is now heated to say 800 deg. C., it will be observed that grain growth has taken place and that there are fewer and larger grains. The melting point of copper is 1,084 deg. C.; this grain growth occurs therefore while the metal is in the solid state. In what is termed "normal grain growth" the higher the temperature and the longer the time at heat the larger will be the grain size. In some cases grain growth is very rapid at a given temperature for a short time, after which longer exposure seems to produce no further change. This is a condition of metastable equilibrium. An increase of temperature usually produces further grain growth in these cases.

DEFINITION OF RECRYSTALLIZATION

When a metal is plastically deformed at a temperature so low that "strain hardening" results, it is said to be "cold-worked." Microscopic examination shows that the grains have been deformed in about the same manner and magnitude as was the piece of metal taken as a whole. Except in the soft metals like lead, tin and zinc, these distorted grains do not change at room temperature. On heating, however, a temperature is reached, different for different metals and for various degrees of cold work, at which the distorted grain structure is replaced by new grains usually approximating an equiaxed shape. By "equiaxed grain" is meant one whose diameter is approximately the same in all directions. Hardness tests show that most of the "strain-hardening" effect is lost with this change in structure. This change is usually referred to as "recrystallization," and the lowest temperature at which new grains visible under the microscope appear may be called the "recrystallization temperature." Recrystallization temperatures for certain metals after severe cold plastic deformation are given in Table I.

TABLE I.—RECRYSTALLIZATION TEMPERATURES

Metal	Approximate Lowest Recrystallization Temperature Deg. C.	Metal	Approximate Lowest Recrystallization Temperature Deg. C.
Iron	450	Magnesium	150
Nickel	600	Tantalum	1,000
Gold	200	Tungsten	1,200
Silver	200	Molybdenum	900
Copper	200	Zinc	Room temp.
Aluminum	150	Lead	Below room temp.
Platinum	450	Tin	Below room temp.
		Cadmium	About room temp.

We intend to present a definite conception of the mechanism of recrystallization which will define "recrystallization" in a fundamental manner. The values given in the table must be considered as approximations and are selected with reference to the lowest temperatures after severe cold work, which will produce new grains *visible under a high-powered microscope.* The recrystallization temperature is lower the greater the amount of cold work, the lower the temperature of working, the purer the metal, the smaller the grains before deformation and the longer the time of exposure at temperature. It is only a matter of usage that the temperature of the beginning of recrystallization should be selected with reference to the appearance of grains which can be seen with a microscope; other measurements such as tensile strength, electric conductivity or hardness give more sensitive indications of the first changes of structure. It is true, however, that when new grains can be seen, the change toward the properties of the annealed metal is marked. Technically, "recrystallization" is the structural change produced in a cold-worked metal on changing from the strain-hardened state to the annealed state. Although there are an infinite number of stages, curves relating certain physical properties to temperatures of heating a cold-worked metal will often show sharp changes within a small temperature range and a gradual change both above and below this

[1] "The Crystalline Structure of Metals," Jeffries and Archer, CHEM. & MET. ENG., May 4, 1921, pp. 771-779.

[2] Iron is an exception to this general rule in that it undergoes an allotropic change at 900 deg. C. accompanied by a complete change in crystal structure with the formation of new grains. Grain growth also takes place in some cast alloys as a result of phase changes.

range. Such curves are given in Fig. 1, showing the tensile strength, elongation and electrical conductivity changes in cold-worked copper heated at various temperatures. A sharp break in all of the curves corresponds to a structural change, the elongated (strain-hardened) grains having been replaced by small equiaxed grains. The sharpness of the changes in Fig. 1 shows the justification for a term such as "recrystallization" to designate the temperature range within which they occur.

If a strain-hardened metal is heated to a temperature just below that of recrystallization, no visible grain growth takes place. On heating to any higher temperature, grain growth takes place, the higher temperatures and extended exposures producing the larger grains.

When metal powders are briquetted and heated to temperatures somewhat below their melting points, grain growth takes place. In the case of tungsten, or molybdenum or nickel powder, the density of the briquet may be only 60 per cent of that of the "solid" metal, but after heating to a high temperature but below the melting point, the density becomes about the same as in the cast or worked metals. On heating these briquets, the grain size normally[3] increases both with the temperature and with time of exposure.

Electrodeposited metals are crystalline. The grain size may be large or small, but heating such a metal may cause grain growth below the melting point.

Iron is unique in its grain growth characteristics because of the allotropic change in a temperature region permitting grain growth. If iron is cast, it first forms grains of gamma iron crystallizing with a face-centered cubic lattice. On cooling, gamma iron changes completely into a body-centered lattice at about 900 deg. C., and this transformation gives rise to entirely new grains. If the iron is kept below 900 deg. C., it behaves much like any other metal within a similar temperature range. It can be cold-worked and hot-worked and the grain growth characteristics can be studied at temperatures up to 900 deg. C. On heating above about 900 deg. C., however, the structure again changes completely into new grains of gamma iron. Every time iron is caused to change from one crystal lattice to the other a new set of grains is produced. Pure gamma iron cannot be "cold-worked," because at the lowest temperatures at which it is stable it cannot be "strain-hardened."

Average Grain Size

Before proceeding with a more detailed account of grain growth phenomena, it will be well to explain what is meant by some of the terms used.

Grains are three-dimensional bodies roughly polyhedral in shape. Our observation of them, especially for the purpose of determining grain size, is usually on a polished plane section. The quantity actually measured is therefore not the volume of the grain, but some linear dimension or area. Furthermore, the grains in a given piece of metal of even the most uniform structure always vary rather widely in size. Rosenhain has pointed out that for practical purposes it is perhaps the size of the largest grains which is of most importance, and some specifications have been written upon this basis, rejecting material which contains grains exceeding a certain stated diameter or area. It is of course probable that the observed plane section of any particular grain does not represent its *maximum* cross-sectional area, but it is also probable that the maximum grain area observed on a polished section containing a large number of grains *does* represent fairly closely the maximum size of the grains.

It is more common to measure the *average* grain size over the observed area. The various methods of doing this will not be discussed, but a preferred method (which has been described fully by one of the authors in this journal[4]) will be outlined for purposes of illustration. The specimen is photographed at a known magnification, or if a photograph is not desired, the image on the ground glass of the camera may be used. A circle is drawn on the ground glass or on the micrograph representing a certain area on the surface of the specimen, selected so as to include a fairly large number of grains, preferably over fifty. A count is then made of the number of grains totally inclosed and also of the number intersected by the circumference of the circle. Twinned portions of grains are not counted as separate grains. The sum of the number totally inclosed plus half the number intersected gives the equivalent number of whole grains within the area of the circle from which the average number of grains per unit area or the average area per grain may be readily calculated. It should be emphasized again that this quantity does not represent the maximum cross-sectional area of the average grain but the average cross-sectional area such as would be cut by a plane taken at random.

A value which we will call the average grain diameter is obtained by taking the square root of the average grain area. This diameter has no exact physical meaning. It represents what would be the length of side of

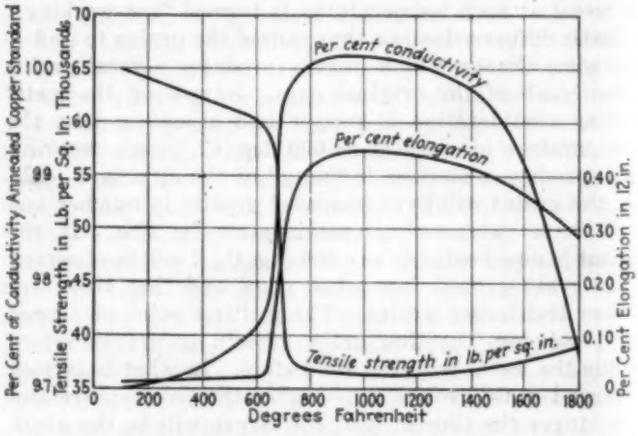


FIG. 1—VARIATION OF PHYSICAL PROPERTIES OF COPPER WIRE WITH VARIATIONS IN ANNEALING TEMPERATURE. (Bardwell, *Trans.*, A.I.M.E., vol. 49, p. 758)

the grains if they were all square. Actually the average grain diameter, determined in this manner, is sufficiently close for all practical purposes to the average intercept cut by a straight line through a large number of grains.[5]

When it is desired to make computations on the basis of volume, the hypothetical square grain may be extended to a cubical grain. The average grain volume is then equal to the cube of the average grain diameter.

It will be seen from the above that grain size meas-

[3] Deviations from this rule will be considered later.

[4] "Grain Size Measurements in Metals," Jeffries, MET. & CHEM. ENG., 1918, vol. 18, p. 185.

[5] It is perhaps most scientific to express grain size in terms of the number of grains per unit area, since this is the quantity directly measured. The authors prefer, however, for general purposes to express grain size in terms of the average drain diameter in inches, with the object of giving as concrete a conception as possible of the actual magnitudes involved.

urements are only approximate. Some have objected to this inaccuracy and attempted by mathematical analysis to arrive at more exact expressions. The objection and attempt are unjustified in view of the real significance of the figures. The properties of metals are not affected to any marked extent by a variation in grain size of 25 per cent or even 100 per cent. Indeed such variations commonly occur from point to point in a supposedly uniform metal. The methods in common use for measuring and expressing grain size are therefore amply exact for the purpose.

Grain growth may occur without affecting the grain size as expressed by average grain area or diameter. During the first stages of growth the total number of grains within a given area does not change and hence the average grain size remains constant. It is not until some of the grains are completely absorbed that the measured grain size indicates the change. Some other means must be used for detecting *slight* grain growth. For most practical purposes, however, we are concerned with grain growth of such magnitude that it is well shown by changes in the measured average grain size.

Elongated Grains

When the grains depart widely and consistently from an equiaxial shape, as in cold-worked metal, it is often better to determine grain size by the intercept method—that is, by counting the grains intersected by a given length of straight line. It will be understood that the grains of a cold-worked metal are broken up into fragments which are in many respects equivalent to individual grains, but that we are here referring to the counting of the original grains. The average grain diameter may be determined in this way both in the direction of working and at right angles to this direction. A complete description of the grains requires measurements in three directions, corresponding to co-ordinate axes, and made on two surfaces usually at right angles to each other. The ratios of the average grain diameters thus determined indicates the shape of the grains and the amount of deformation that the metal has undergone.

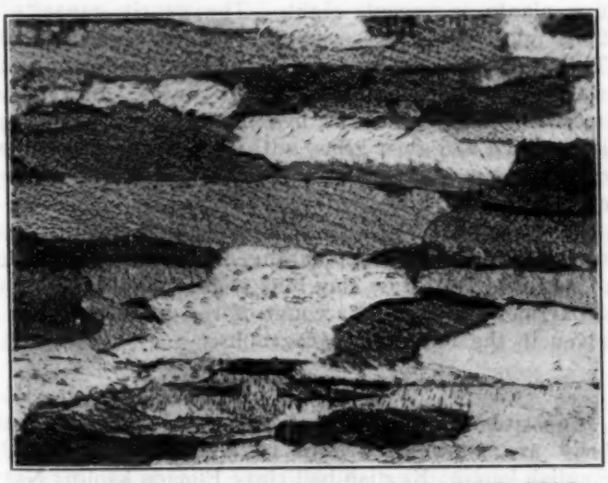


FIG. 2—UNSTRAINED GRAINS SIMULATING COLD-WORKED METAL IN DRAWN TUNGSTEN WIRE 0.020 IN. DIAMETER. × 250 (SYKES)

The term "worked metal" will be used in this article to denote metal which has been subjected to mechanical working of any kind, hot or cold, by rolling, forging, pressing, swaging, drawing or otherwise.

The word "strain" is used very commonly in connection with grain growth in a sense not altogether obvious. From the physical or mathematical viewpoint any deformation is a strain, including the elastic deformation represented by the first portion of a "stress-strain" diagram. But an elastic deformation does not constitute a strain, according to usage in connection with grain growth. Strain is sometimes used to denote stress, and at least carries an implication of this meaning. "Strain" as used in these pages does not necessarily involve stress. We may define a *strained metal* or grain as one which has been permanently deformed in such manner as to harden it. A hot-worked metal is not strained. The strain of a cold-worked metal is removed by annealing.

The hardness produced by work is called strain hardness or work hardness.

Unstrained grains are normally equiaxed in shape, but exceptions are very common. When a metal containing material which mechanically obstructs grain growth is subjected to considerable working, either hot or cold, it is often found to exhibit grains which are consistently elongated in the direction of the working, even after thorough annealing. An example of this type of structure in tungsten is shown in Fig. 2. These grains are unstrained, though not equiaxed. A distorted grain shape suggestive of cold-working is not therefore to be regarded as proof of strain.

When a metal solidifies in a chill mold it is often found that long grains grow out at right angles to the walls of the mold. These grains are referred to as "columnar," and they are of course unstrained. If the mold is circular or nearly so in cross-section, the grains converge toward the center, and may then be referred to as "radial grains."

(Part II, on Experimental Data and General Laws, will be published in a subsequent issue.)

Use of Rubber in Paper Manufacture Proves Advantageous

Experiments on the quality of paper in the manufacture of which small amounts of rubber latex are added to the fiber seem to demonstrate that the product is superior to the same material made without rubber. Vice-Consul Wade Blackard of Singapore reports the results of tests in the Feb. 13 issue of *Commerce Reports*.

It is claimed for the process that it will not only reduce the cost of paper manufacturing materially and simplify paper-making methods, but that it will greatly improve the quality of the product.

Experiments were made to show that with an ordinary fiber made into a paper containing one-tenth of 1 per cent of rubber the product had a folding number of 5,000 to 6,000 and a tensile strength two or three times that of the same material made without rubber. But with a rubber content of about seventy-five one-hundredths of 1 per cent the folding number reached 14,500, while the same paper made in the usual manner had a folding number of 30.

Another fiber beaten for half the usual time made into a paper containing 1 per cent of rubber had a folding number of 72,500 and a tensile strength of 87 lb. for a strip 1 in. wide, equal to 6,600 lb. per sq.in., or about twice the strength of a well-vulcanized rubber compound, such as is used in tires, for example. The bursting strength was about 40 lb. for a thickness of one-tenth of a millimeter.

Pottery Manufacture in the East Liverpool District

Plant Operations in the Manufacture of Semi-Vitreous China at Plant No. 5 of the Homer Laughlin China Co.—Raw Materials—Producing the Slip—Magnetic Separation—Filtering—Forming—Making the Glaze—Burning—Important Economic Factors

By CHESTER H. JONES

EAST LIVERPOOL, Ohio, located on the north bank of the Ohio River and connected with Newell and Chester, W. Va., on the opposite side, by steel bridges, makes one community dependent on the pottery industry and is the center of the manufacture of tableware in the United States. It is comparable in this respect with Stoke-on-Trent, in England, a town long the center of production for English china. The location of pottery manufacture at East Liverpool is purely traditional, for no native clays are used in the whiteware plants.

In 1839 James Bennet, an English potter, found a good clay here for making yellow and Rockingham ware. The general manufacture of whiteware began in 1879 and was followed by the use of underglaze decoration. The development of semi-vitreous china came about 1890 with better clays, different mixes and harder firing. The present product is an outgrowth of the white-granite ware and is known variously as semi-vitreous china, semi-vitreous porcelain, semi-porcelain and porcelain granite.

The plants and workmen were available for white ware manufacture, and conversion from yellow ware required only a change of raw materials. These were brought together from many scattered points, causing this location to develop into the largest center for the industry. Whiteware is the type of tableware having a fairly porous body covered with a brilliant transparent glaze. It has the general body composition of 52 per cent clay, 34 per cent flint (ground quartz) and 14 per cent feldspar.

The clay content is kaolin and ball clay. The former, being non-plastic, burns white, the latter, being very plastic and tenacious, fires to a cream or buff color. Kaolin gives whiteness and ball clay plasticity and bonding strength. Flint reduces drying shrinkage and gives rigidity during firing. It further promotes the escape of steam and gases during the period preceding vitrification. Feldspar fluxes at the higher kiln temperatures to a glass which dissolves some of the quartz and clay, cementing it into one mass. The amount of feldspar used in white ware does not completely eliminate pore space, which is the principal distinction between white earthenware and porcelain.

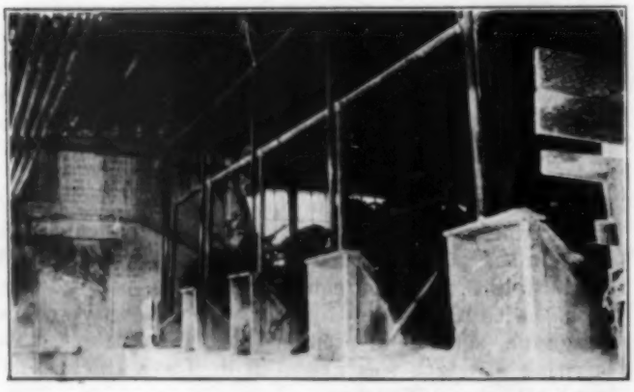


FIG. 1—VIEW ALONG TOP OF BLUNGERS

The chief producers in the district are Knowles, Taylor & Knowles, M. C. Nichol Pottery Co., Thompson Pottery Co., West End Pottery Co., Taylor, Smith & Taylor, A. M. Knowles, Vodrey and the Homer Laughlin China Co. Of these the last named is perhaps the best for description of the process.

The Homer Laughlin China Co. was started by Homer Laughlin, an English potter, in 1871. He erected and operated a two-kiln white ware plant and for many years was loath to expand for fear of sacrificing quality in quantity production. The company, with main offices in Newell, W. Va., now operates five plants, Nos. 4 and 5 being located in Newell and Nos. 1, 2 and 3 in East Liverpool. The total number of kilns in these five plants is seventy-eight. The yearly capacity is 2,000 glost kilns, or seven carloads, of china per day. This is approximately one-fifth of the amount of tableware manufactured in the United States. In 1920 the actual production of the five plants was 1,237 bisque kilns and 1,935 glost kilns, with an average natural gas consumption of 273,000 cu.ft. per bisque and 242,000 cu.ft. per glost kiln.

In 1914 Plant No. 5 was completed, and since it is the most recent of the group arranged for straight line flow of material from raw clay bins to packing and shipping department, a detailed account of the operations will be given in the following paragraphs.

Preparation of the Body

Constituents or raw materials used in making the body are all shipped into the district and include: English kaolin; English ball clay; Florida kaolin; North Carolina kaolin; feldspar; flint.

These are unloaded from railway boxcars to separate bins, whence they are drawn in required proportions to industrial car scales. This batch scale car is pushed by hand along the track directly to the rear of the battery of five blungers. Fig. 1 is a view along the top of the blungers. The car enters from the raw materials building through the double door on the left of the view and the batch is shoveled through the wooden charge openings appearing on the top of each blunger. Water is introduced through the pipes entering the top near each material charge opening.

The blunger tanks as well as the agitators or cisterns for holding slip are constructed from brick and concrete. The agitating mechanism consists of five single vertical shafts with paddles for each blunger connected by bevel gears to the continuous horizontal shaft running along the battery. Each gear on this shaft runs

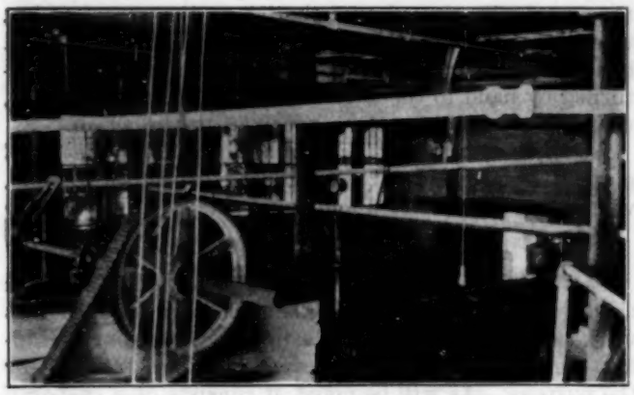


FIG. 2—FILTER PRESSES

as an idler until thrown in by separate clutch, thus permitting the individual operation of any blunger. Clutch operating handles are seen adjacent to the feed openings and convenient to the charging floor operators.

The main shaft is driven from electric motor by silent chain, as shown to the left in Fig. 2. This view also shows three of the five filter presses arranged on the main floor in front of and below the blungers with details of overhead water main leading to blungers and slip piping to the filter presses.

Treating the Slip

When the mixture of body materials and water has been whipped to the required consistency in the blunger to form a creamy slip, it is drawn from the bottom to a common header trough running along the front of the battery between blungers and filter presses and flows into an agitated cistern below the floor. Like all other storage tanks for clay slip, the liquid must be kept continually in motion by slowly revolving paddles mounted on a vertical shaft. Otherwise the solids would settle out of solution, rendering the pumping system immovable. The mechanism for driving the agitator below floor appears beneath the cage in the foreground of Fig. 3, and consists of bevel gearing with suspended agitator shaft driven by belt from overhead shaft.

From this agitator the slip is pumped by double-piston heavy-duty slip pump to the two large brick agitators above floor level, as shown in the background of Fig. 4. From each of these the flow continues to the revolving lawns in the foreground, where it passes through 12XX silk equal to a 150-mesh brass screen. Both lawns discharge directly into the Type U Dings Magnetic Separator, which is the low box appearing in the right front of the picture.

The slip enters the magnetic separator through pipes in the rear end. The removable iron riffle bed is magnetized by 220-v. current from below, and as the liquid travels over the tortuous path all particles of solution are brought in contact, causing any native or abraded iron particles to adhere. At the discharge end of the separator the flow passes over a swinging cradle held stationary in place by an electromagnetic coil connected in series with the main magnetizing circuit and so arranged that should the power go off it will swing out of place by its own weight and cause the solution to fall in a launder for recirculation through the storage cisterns above. This insures that all clay passing through the separator will be cleaned of iron by the current.

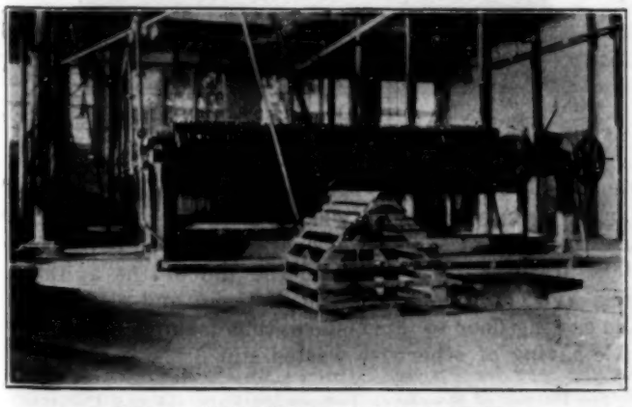


FIG. 3—ANOTHER VIEW OF PRESSES

Deposits of primary kaolins very low in iron opened up in the United States are so far quite rare. England is more fortunate in this respect, which accounts for the American potter's preference for the imported English clays. On the other hand, plastic ball clays of very good quality have been located in both Tennessee and Kentucky.

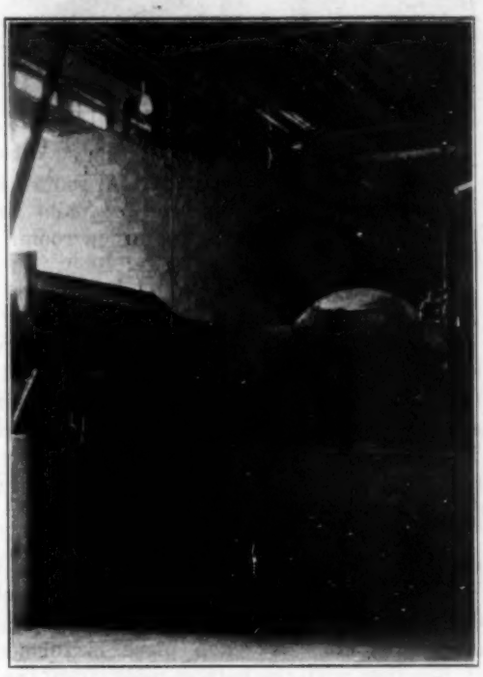


FIG. 4—BRICK AGITATORS AND REVOLVING LAWNS. MAGNETIC SEPARATOR IN FOREGROUND.

Filtering

The iron-free slip passes directly from the separator to a pair of agitators below floor level, whence it is pumped by Patterson heavy-duty pumps operating at 80-lb. pressure into the battery of five filter presses shown in Figs. 2 and 3. Cakes of plastic material are put through an English Boulton pug mill in the adjoining room. The filter cloths are thoroughly washed at frequent periods to prevent premature decay through bacterial action. This is done in a wooden box supporting a squirrel-cage rotor in which the cloths are revolved as the fresh water plays through the apparatus. Creosote is added as a preservative during this washing process.

From this point the pugged clay takes two courses through the plant. Part is used directly in the forming or jiggering department, the remainder goes to make up the colloidal solution or casting slip. Molds for use on the jiggers and for the casting process are produced

FIG. 5—SECTION OF JIGGER ROOM.

on the same floor as the preparation room just described. Large quantities of plaster of paris are consumed in a very complete mold production room.

JIGGERING

Fig. 5 is a view of one small section of a large jigger room. The tables are arranged in one long row with the light from outside windows giving perfect illumination. Instead of placing the tables directly against the wall, as is commonly practiced, the space in front, as shown in the picture, permits the delivery of clay to the front of each bench by hand truck without interfering with the jigger operator.

The jigger shown in the foreground is for use in throwing a variety of the deeper pieces, a long up and down travel being obtained by motion of the collar on the column. To the left rear is an ordinary jigger for throwing plates, etc. As each piece is formed it is removed, together with the bottom mold, from the jigger and placed on the ferris-wheel driers seen directly back of the operators' benches.

Fig. 6 is a close-up view of the loading side of one of these driers. The outfit consists of a large room with board walls which is heated by steampipes. The revolving ferris-wheel arrangement of shelves filling this space is moved by the operator, who turns the crank communicating with the worm and gear attached to the main shaft as often as he desires to bring empty shelves in front of the opening for loading. Piece and mold are thus gradually passed over the top to the opposite side, where they are removed after remaining for 8 to 12 hours in the drying atmosphere. The molds are returned by hand to the shelves shown on the left, Fig. 6, where convenient for the jiggerman to use again.

After trimming off the rough edges from the dried pieces, they are transferred to the green ware room, where all ware is sorted and counted.

FIG. 6—DRIER

CASTING DEPARTMENT

Casting slip is prepared near the pugging room on the first floor. Fig. 7 shows the apparatus used for this work, a machine made by Gosling & Gatensburg, Hanley, England, which has proved very satisfactory for the purpose. As will be noted, it consists of a cast-iron cistern placed with the top near the floor level, with a small blunger on the right set directly on top of the cover. The belt-driven cross-shaft above drives both the blunger shaft and agitator shaft through bevel gears. The batch of pugged clay, sodium silicate and sodium carbonate is put in the blunger through the top cover. These latter reagents operate to make a heavy but fluid suspension with reduced water content.[1] When thoroughly agitated the batch is drawn to the lower and larger agitator beneath, whence it is later pumped for use to tanks on the floor above. Two troughs or launders are seen emptying into the top of the agitator, Fig. 7. These convey waste material and slops from the casting floor to this cistern, thus making a considerable saving of otherwise wasted slip.

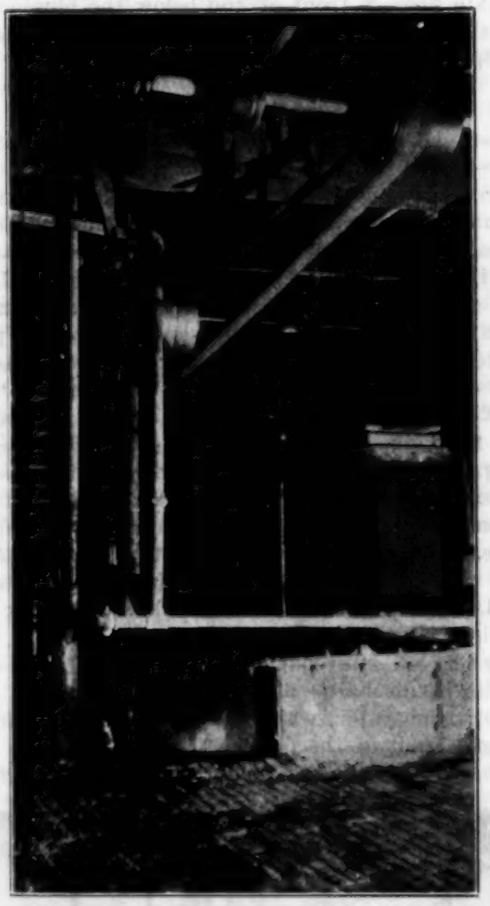


FIG. 7—APPARATUS FOR PREPARING CASTING SLIP

[1]See Bureau of Standards Technologic Paper 51 and University of Illinois Bulletin 17, both by A. V. Bleininger.

Fig. 8 is a view of a small section of the casting room. On the upper right hand appears one of the tanks which receives the slip from the apparatus described above, together with the piping system for serving material to the operators. In the foreground are typical plaster of paris molds used for casting all sorts of ware such as vegetable dishes, sugar bowls and even cups and large pitchers complete with handles. The casting of ware with handles is a distinct advance over the old operation in which cast handles are attached by hand after the main body of the piece has been thrown on the jigger.

Clay slip is drawn into the molds through the valve on the hose outlet, one of which appears lying on the molds in the foreground. After standing a few minutes, the excess slip is poured out, the mold is parted and the cast piece is trimmed and ready for transportation to the green room.

Making the Glaze

The glaze is prepared from frit or glassy constituent, boric acid, borax and other mill additions. The frit is prepared from the following typical formula:

	Lb.
Boric acid	100
Borax	50
China clay	25
Flint (natural)	180
Lime	8
Flint from sagger linings	80

This is placed in saggers in the kilns and melted to a glass. The company has recently erected a gas-fired reverberatory furnace to replace the practice of using

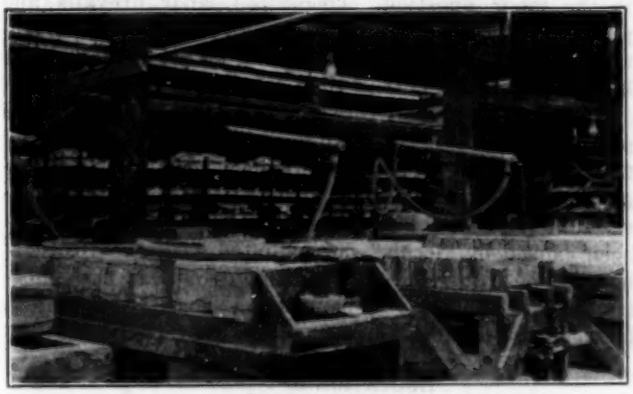


FIG. 8—SECTION OF CASTING ROOM

saggers. This glass or frit is removed to the glaze room, where it is ground in the chaser mill. During the grinding, china clay, flint, whiting, zinc oxide and feldspar are added, the whole being thoroughly mixed and ground in the dry state. The composition of this mixture must be such as to produce a glaze which will fit the bisque body according to the degree of burning of the body. It is a matter of obtaining proper coefficient of shrinkage of the glaze.

Fig. 9 is an interior of the glaze room. To the right is the track scale into which the mill additions are weighed and transported to the chaser mill, the latter not shown. The mixture from the chaser mill is carried to the four 1,200-lb. Patterson pebble mills on the left, where it is ground wet to a creamy consistency. These mills are emptied to boxes beneath. These, in turn, discharge to a common launder leading to the hexagonal rotary lawn appearing beneath the pebble mill in Fig. 10. This lawn is covered with No. 14 lawn silk. The lawn box empties to an agitator tank beneath the floor,

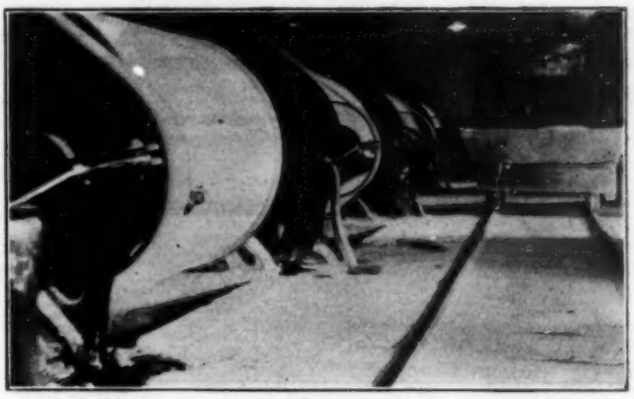


FIG. 9—GLAZE ROOM

whence the glaze is pumped by the small outfit, shown on the left of the view, to the dipping department.

The glaze tanks in the dipping room are all provided with agitators. Glaze is drawn off in ordinary galvanized washtubs, the ware which has received the bisque burn is dipped therein by hand and subsequently dried over steam pipes. It is then returned to the main kiln room, where both the glost and bisque burning is carried on. Ware from the green room here receives the bisque burn and is passed on as mentioned to the glaze room. The bisque is stamped with the trademark, plant and lot number just before dipping in the glaze.

Sagger Production

The sagger department is located in the basement. The mixture used consists of 50 per cent grog from broken saggers, with the balance a mixture of two clays. One is open firing and refractory, while the other clay is dense firing, though somewhat less refractory. Both are American clays.

Both hand molding and machine are employed in the forming. In the latter case a motor-driven Crossley sagger machine is used to develop about 1,000-lb. pressure per square inch. The sagger glaze mix consists of:

	Lb.
Whiting	30
Plaster	5
Feldspar	250
Flint	75
China clay	70
White lead	120
Red lead	20

Burning

Gas is burned at 45c. per 1,000 cu.ft. While this is expensive, there is a production saving of 15 per cent more ware as compared with coal firing. In the winter coal is used on the bisque kilns and some glost kilns and

FIG. 10—HEXAGONAL ROTARY LAWN FOR GLAZE

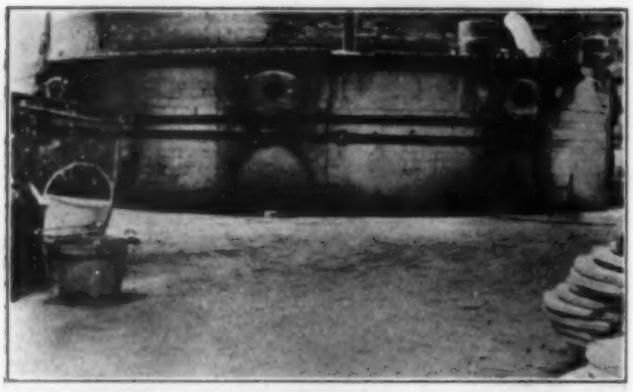


FIG. 11—UP-DRAFT PERIODIC KILN

for the purpose coal grates on wheels are inserted under fireboxes.

The main kiln room has seven bisque and nine glost kilns. They are 18 ft. in diameter, up-draft periodic type. Fig. 11 shows two of the fireboxes on a kiln with gas pipe feeding through the ash door opening. Cones and draw trials are used to determine and regulate ordinary firing conditions. Veritas disks are used when trouble occurs and occasionally Albany and body trials are employed. The bisque is burned to cone 8 and the glaze to cone 6.

Lowden overhead tram system is employed for handling saggers, coal and ware to and from kilns. A complete coal-handling system is installed. Standard gage railroad hopper cars dump to bin beneath track. Outlet permits coal to drop to pit at one side of track. An electrically driven hoist with grab bucket takes coal from this pit and deposits it either on the storage pile beneath overhead trestle or to overhead bin, whence it is transported to the kiln room.

Decorating Department

There are three general methods of decorating the ware after the glaze is burned on. Line decoration involves the spinning of the piece on a small horizontal wheel while the brush is held against the surface. Stamp decorating employs a rubber stamp with pad and is confined principally to the application of gold designs. Decalcomania is a transfer paper with the design printed thereon from lithograph stones. The inks are mineral colors. The design adheres to the varnish, previously applied on the proper portion of the ware, when the paper is washed away. All these operations are carried on by hand. The production of decalcomania paper has been improved by double and triple printing on lithograph presses which piles up the ink, giving a relief effect when burned onto the ware. Each pottery purchases exclusive designs by the sheet from the decalcomania manufacturer. About fifty open patterns are kept in stock. The artistic development of the decalcomania within the last 5 years has been very great.

There are four gas-fired, square, muffle type decorating kilns, each having two chambers. Coal is fired on grates along each side. The temperature reached corresponds to cones 018 and 019. Where gold and color is used in the decoration the ware must be twice fired. Inspection and packing in sets complete the production feature.

Economic Factors Important in Pottery Manufacture

The American pottery industry is today in a far more advantageous position than before the war, but it is still subject to several important factors. One of these is the necessity of importing English kaolins and ball clays, which, contrary to the broad statements of chemists not thoroughly familiar with the industry, are essential to the production of tableware. Potters would be glad to use domestic materials if it were possible to do so and are even now introducing as much North Carolina and Florida kaolin as they dare to use. The position as regards ball clays is more favorable and it should be possible in time to eliminate a large part of the imported clays. Some of the Tennessee and Kentucky clays are already being used and recent developments in Missouri afford additional hope.

The great need is, however, for primary kaolins found in sufficient quantities and of good quality. The North Carolina kaolins at the best are extremely valuable materials, but unfortunately they are subject to variations due to their fluctuating mica content, which renders them more or less unreliable. Furthermore, the quantities available are not sufficient to supply the whole trade. The plastic kaolins of Florida and Georgia can be used in smaller proportions, but these offer real difficulties because of their fine-grained, partly colloidal nature.

It is to be hoped that the search for suitable kaolins will be continued until ultimately it will be possible to depend entirely upon domestic raw materials. As regards the flint and feldspar, we have an ample supply of these rocks.

Labor

The second important factor in the pottery industry is the labor question. Organized labor prevails and piece work is the rule. This system has both its advantages and disadvantages. It cannot be denied that labor has been unreasonable in the past, but this is true of all other industries. On the other hand, the Brotherhood provides the potteries with trained men who have served their apprenticeships and are skilled workers. This organization has also shown wise moderation during the recent wage settlement and the trouble that existed has been caused by "locals" not affiliated with the Brotherhood. The future development and growth of the industry will undoubtedly depend upon closer co-operation between the manufacturers and the craftsmen.

Educational Needs

One of the needs of the situation is an opportunity for the pottery workers to be trained in properly equipped schools in the technical fundamentals of the trade. Such a beginning has been made at the Trenton School of Industrial Arts and it will be necessary to found similar institutions at several of the clay-working centers. It is essential that an opportunity to improve himself be offered the ambitious workman. It cannot be expected that a large proportion of the potters would avail themselves of such training, but those who do will constitute the nucleus from which foremen and superintendents can be chosen. This has been realized for some time in Europe, where trade schools open to workers have been in existence for many years, and attention need be called only to the schools at Stoke-on-Trent in England, Levres in France, Bunzlau and Hoehr in Germany and Teplitz in Bohemia.

The writer is indebted to W. E. Wells, Jr., general manager, and A. V. Bleininger, chief technologist, for courtesies extended during visit to the plant and information furnished for the preparation of this article.

Chemical Warfare and the Arms Treaty

Abolition of Gas Warfare by Proposed Treaty Is Shown to Be Impractical and Not in Harmony With the Best Technical Opinion—Alternative Procedure Suggested to U. S. Senate and a Review of the Facts Upon Which It Is Based

By R. S. McBRIDE

IN THE TREATY on submarines and chemical warfare, the representatives of the five principal world powers have returned a signed indictment of the use in war of noxious gases and chemicals. Now it remains for the Senate of the United States to try the case of the indicted criminal, gas.

In this article there will be no attempt to propose just what the Senate of the United States should do with this particular treaty. The effort will be rather to set forth certain *established* facts and other *alleged* facts which should be taken into account by the Senate if this treaty is to receive proper consideration from the standpoint of the needs of the American people.

The following is the only section of the submarine treaty (so called because all other sections treat of submarines) which deals with the question of the use of gas. It is section 5:

> The use in war of asphyxiating, poisonous or other gases, and all analogous liquids, materials or devices having justly been condemned by the public opinion of the civilized world and a prohibition of such use having been declared in treaties to which a majority of the civilized powers are parties, the signatory powers, to the end that this prohibition shall be universally accepted as a part of international law binding alike the conscience and practice of nations, declare their assent to such prohibition, agree to be bound thereby as between themselves, and invite all other civilized nations to adhere thereto.

What Led to This Treaty Proposal

Strong public opinion against the use of gas in warfare developed spontaneously after the famous chlorine attack made by the Germans on the Canadian troops at Yprès. This sentiment grew steadily during the remaining period of the war and still remains a powerful factor throughout the country. As a consequence a few hundred thousands of the communications which came to Washington from individuals, associations and others during the late Arms Conference urged the abolition of the use of gas in war.

A technical sub-committee of the Arms Conference was appointed to represent the five principal powers affected. This committee consisted of seven members, two each from the United States and France, and one each from Great Britain, Italy and Japan. The advisory committee of the American delegation, consisting of a group of private citizens and public officials selected more or less as spokesmen of American public opinion, also gave consideration to the question of gas. It was on the basis of the reports of these two committees and of a third document submitted by the General Board of the U. S. Navy that the American delegation based its conclusion that gas warfare should be prohibited.

The full texts of these several documents have already been made public, but it is believed that their important bearing on the present situation warrants a brief review of their salient conclusions. It will be recalled that the representatives of the five signatory powers who acted as technical experts in the consideration of gas warfare were of the opinion that it was impractical to prohibit chemical warfare. The committee reported, among other things, that neither the research nor the production of warfare gases could be prohibited, restricted or supervised and that therefore "no nation dare risk entering into an agreement which an unscrupulous enemy might break if he found his opponents unprepared to use gases both offensively and defensively."

The American delegation and the Arms Conference itself, however, did not accept this technical interpretation of the situation. In this respect it departed materially from the policy which it apparently followed throughout all of the rest of its deliberations. In all other cases it appears that the Conference reached its conclusions on technical subjects after weighing carefully but finally approving the consensus of technical opinion. It certainly did so in the case of the conclusions reached with respect to submarines, aircraft and the exact disposition of naval vessels.

The Advisory Committee and Navy Reports

A sub-committee of the advisory committee, under the chairmanship of General Pershing, also labored over the matter, and its report was presented *in extenso* to the Arms Conference by Secretary Hughes. After reciting general statements as to the development of gas warfare, the committee concluded that "whatever may be the arguments of technical experts, the American representatives would not be doing their duty in expressing the conscience of the American people were they to fail in insisting upon the total abolition of chemical warfare, whether in the Army or the Navy, whether against combatant or non-combatant."

As a result of its deliberations, the American delegation adopted in substance this advisory committee report despite the fact that the advisory committee was far from unanimous in recommending it to the delegation. It is reported that the split on this particular resolution was, in fact, one of the most serious points of friction in the entire proceedings from the standpoint of the American advisers.

At this point there was injected into the discussion, "for the information of this committee," a report by the General Board of the U. S. Navy, which said categorically "Yes" in answer to the question, "Should gas warfare be prohibited?"

The comment of the General Board of the U. S. Navy cannot be regarded as a technical discussion of the question, but it appears to have had considerable influence with the delegation, possibly because it stressed the frightfulness of the use of gas against non-combatants.

The American delegation after considering these re-

ports laid before the Arms Conference a resolution which was presented by Mr. Root. This resolution strictly forbade in any way use of asphyxiating, poisonous or other gases, and all analogous liquids or poisonous devices. It was in substance identical with the final form of the treaty provisions quoted above. This resolution was adopted by the Conference unanimously and became the basis for its final recommendations which now are before Congress.

An Alternative Procedure Now Suggested

Those who have studied the subject carefully, particularly those who have had long experience and know gas warfare, believe that the conclusions of the Arms Conference were in error in their interpretation of the function of gas as a military weapon. They all admit that there are highly improper uses of gas, just as there are recognized misapplications of the submarine and aircraft. However, basing their conclusions upon certain facts, or alleged facts, they insist that the proper procedure would have been to define as clearly as may be the misapplication of gas, and provide penalty for such misapplication, rather than to have attempted to prohibit its use. In other words, they would place gas in the same category with submarines and provide correspondingly. One alternative which has been proposed uses the substance of the treaty above discussed and by re-wording it but slightly accomplishes this result in the following language. (The italicized words in paragraphs 1 and 2 and all of paragraph 3 are the new portions):

> The *wrongful* use in war of asphyxiating, poisonous or other gases and all analogous liquids, materials or devices having been justly condemned by the general conscience of the civilized world.
>
> The signatory powers, to the end that the prohibition of this *wrongful* use shall be universally accepted as a part of the international law binding alike the conscience and practice of nations, declare *that the use of these materials in any form against cities or against bodies of non-combatants of a belligerent or neutral country is a violation of the laws of war, and they* agree to be bound thereby as between themselves, and invite all other civilized nations to adhere thereto.
>
> The signatory powers do further declare that any person in the service of any power who shall use these materials in any form against cities or bodies of non-combatants shall be deemed to have violated the laws of war and shall be subject to trial and punishment as in the case of persons violating the rules adopted for the regulation of submarine warfare.

Six Pertinent Facts

In urging the adoption of this alternate form of treaty obligations certain important facts and opinions have been enunciated. It appears that the Senate of the United States should, and it doubtless will, carefully consider these points. They may be briefly summarized as follows:

(1) Gas as a military agency can be developed by research and its manufacture continued in secret indefinitely, if any nation wishes, despite any number of international agreements to the contrary. In this respect it differs fundamentally from battleships and fortifications, which cannot be so secretly constructed and preserved.

(2) Gas in its application in war can be as accurately controlled as to its objective as can high explosive, shrapnel or small arms missiles. It is urged that there is absolutely no justification for the claim that it necessarily is used against non-combatants as well as combatants if used at all.

(3) Gas is demonstrated to be the most effective and probably the most economical weapon; and it is claimed by those who have thoroughly studied the subject that it is fully as humane a weapon as any other. Assuming a demonstration of these three important points, gas would certainly qualify as one of the most acceptable potential weapons of modern war, even assuming that that war is to be a "civilized" one.

(4) The Chemical Warfare Service as a military agency cannot limit itself to offensive military preparedness, for it is essential to have at all times defensive measures provided for the protection of our troops in case an unscrupulous potential enemy might violate an international agreement.

(5) Effective preparation for defense against gas warfare demands thorough study of offensive measures that may be met. Moreover, the surest guarantee that offense measures will not be used contrary to agreement is the fear of retaliation on the part of the better prepared enemy. Thus it is argued that means for offensive warfare of this type must always be maintained not only on an experimental scale, but upon a scale capable of expansion to large units very quickly.

(6) The Chemical Warfare Service, furnishing as it does an important link in the chain of chemical industries, contributes to peace-time welfare of the community through this and other means quite sufficiently to justify its cost even though its military value as a measure of defense were entirely ignored.

Demonstration of these six points in convincing detail is out of place here. Some of them, as pointed out below, are easily demonstrable. Others have been less clearly established. Nevertheless they are set forth and insisted upon by those who should know and who probably can at the proper time bring forth evidence for their conclusive support. At this time, therefore, it is urged only that these facts and opinions be not ignored, but that effort be made to bring out all the points pertinent to them before this nation shall have irretrievably committed itself to a policy upon which there is still ample ground to justify difference of opinion.

Controllability of Gas

It requires no elaborate argument to demonstrate the unquestioned correctness of the first point made—namely, that research and development, even manufacture, of gas offense material can be continued in secret if desired. This research and development, in fact this manufacture, is going on as a part of regular chemical industry and will continue as such without regard to the military significance of treaty obligations. It is quite as hopeless to attempt pre-control by agreement of these things as it would be to attempt pre-control of the judgment of the commander of a submarine. The integrity of those in charge must be trusted to determine what use will be made of such facilities or of such submarine. Only the honorable character of these persons will determine what the application will be. Their existence cannot conceivably be prevented.

The controllability from the standpoint of who is harmed by use of gas is a question not quite so clearly established. Experiences of non-combatant populations subjected to gas are reported from the late war. That such experiences were not uncommon need not be questioned, but there is no question that non-combatants were similarly harmed by the misapplication of bombs and other explosives dropped from airplanes or by missiles of all types from small arms to the largest of high-explosive shell. Technical experts seem unanimous

in their statement that gas *can* be applied as accurately to an objective as can any other weapon.

An unscrupulous enemy might apply it to non-combatant as well as combatant. In fact, the advisory committee seems to fear this frightful and unrestrained use of gas, if it is permitted at all, more than any other feature. But there is no reason why there should be such application than there is that an enemy should sink passenger vessels unwarned or hospital ships traveling solely on errands of mercy. The choice is strictly his.

Effective, Economical and Humane

The large percentage of casualties experienced in the last war from gas is a complete demonstration that gas is one of the most effective weapons of modern war. The experience of the late war was also a complete demonstration that from the standpoint of money cost it is one of the most economical agencies of offense.

It is estimated that proper defensive measures for protection of America could be at least fifty to one hundred million dollars per year less if it were permitted that our Army and Navy use gas as one of the agencies against the combatants of an attacking enemy. It is insisted by those who have studied the subject that this tremendous annual saving could be accomplished even though the total expenditure for all Army and Navy agencies were only to be one-half to one-third of the present total, which is between one-half and three-quarters of a billion dollars per year. Unless the enemy can gain absolute control of the air, thus blinding our military forces in this element, and then be free to attack as he wills from the air, the defensive measures which can be accomplished by gas used upon landing places give tremendous advantage to a defensive force. The advantage is so great, indeed, that it is urged that other expenditures of all types could be materially reduced without it any way curtailing the effectiveness of the defense provided.

The third claim regarding gas as a weapon—that it is as humane as any other—is also demonstrated. It is shown that the percentage of recovery of gas casualties has been very much higher than the percentage of complete recovery from any other cause of casualties. Medical investigation seems to have established the fact that there is no justification for the assertion that tuberculosis, pneumonia and the other diseases claimed as after effects of gassing were so caused. It is also insisted that the suffering caused at time of casualty is no greater when a man has been subjected to gas than if he has been *equally* disabled by bayonet, shrapnel or high explosive.

Since it is upon the basis of humanity and humanitarian considerations that the decisions of the Arms Conference were reached, it would seem essential that this point should be thoroughly studied in the light of the latest and the best information which can be brought before the Senate of the United States.

Continuance of C.W.S.

The British representatives in addressing the Arms Conference were so outspoken in their interpretation of the proposed treaty that it seems there need be no doubt in the minds of the American people on the same point—namely, that the treaty does *not* mean any interruption of measures of preparedness from the standpoint of defense. It seems reasonable to assume, therefore, that the question of continuance of the Chemical Warfare Service as a branch of the Army is not raised by the discussion of this clause of the treaty. In any event, C.W.S. can be defended very convincingly as a defensive unit and as a unit of peace-time value quite worth its cost.

What Shall Be Done About It?

The Senate of the United States is already considering these treaties. The Senate is a deliberative body reaching conclusions after thorough consideration and serious debate pro and con. It would not be fitting or proper that the chemical industries of the country, which have the most intelligent appreciation of the present situation, should take the initiative and attempt to dominate this situation, even on the ground of the superior knowledge of the question. The matter is one of public policy and public opinion, rather than of science and technology.

Despite this limitation which expediency places upon the chemical industry at this time in this matter, the industry can and should insist that the Senate carefully bring out all facts bearing upon the usefulness, the "frightfulness" and the humanitarian aspects of gas warfare.

If the Senate will carefully and thoroughly delve into the subject, there is no question that it will reach a sound and proper conclusion. Whether this conclusion will be to ask the President to negotiate a slight amendment of this section of the treaty, whether it will be to accept the treaty with clear understanding in their own minds as to what limitations must inevitably be placed upon its meaning, or whether the flaws alleged to exist will be deemed sufficient to cause rejection of the treaty as a whole and insistence that this section must be omitted before ratification, only time can tell.

If, as is urged by some, the conclusions of the Arms Conference were based upon a misunderstanding of the facts, then the Senate can well take some course leading to appropriate amendments of the Conference recommendations. However, to urge this now would be quite unseemly, for some of the greatest minds that present-day statesmanship can furnish have studied these questions and reached deliberative conclusions. All that can or need be asked is that the review of the situation by the Senate be thorough and impartial.

Investigation of Abandoned Magnesite Beds

Previous to 1860, most of the epsom salts used in the United States was made from magnesite mined in Pennsylvania. The demand for magnesite on the Atlantic seaboard resulted in an investigation by the U. S. Geological Survey as to the possibility of again working the Pennsylvania deposits profitably.

The work done, which consisted of re-excavating the pits, quarries, open cuts and a shaft that had become filled with dirt, showed that the magnesite occurs in a fine network or stockwork of small veins, most of them less than an inch thick. Two veins were uncovered, one about 14 in. wide and the other about 12 in. wide. A thorough exploration, including the reopening and drainage of a shaft with underground drifts, failed to disclose any larger veins, but it is reported that a body of magnesite about 30 in. wide was found in the shaft at the crossing of two principal veins.

The development work completed last fall shows that the quantity of magnesite available close to the surface is very small and that many tons of waste would have to be handled to produce a single ton of ore, and production on a commercial scale was therefore not attempted.

Centrifugal Casting

An Art Known for Over a Century—Requires Careful Adjustment of the Cooling Rate, Which Is Controlled by the Temperature of the Mold and of the Liquid Metal—Recently Adapted to Steel and Monel Metal

BY L. CAMMEN

IN THE present paper it is intended to describe the process of centrifugal casting of hollow metal objects. Actually, however, centrifugal casting has been successfully applied to the production of non-metallic tubes, such as concrete pipe (Hume process). It has also been used for the production of solid castings, by locating the molds around the rim of a spinning wheel. By this method dense aluminum castings have been obtained, as well as concrete blocks and precast shapes.

THE ART IS OLD

The art of centrifugal casting of hollow metal objects is quite old, and has been practiced on a commercial scale in England since the beginning of the last century, the earliest patents dating as far back as 1809. About the year 1852, Shanks, in London, made cast-iron gas pipe, 12 ft. long, 3 in. in diameter, by pouring molten metal into a spinning wrought-iron mold. He also applied his process to the manufacture of iron sheets for roofing, by casting cylinders, 9 in. long, 6 in. diameter and about 0.01 in. wall thickness. These cylinders were then carefully annealed, cut open and flattened out. The process was kept secret, and these sheets found a ready market for a long time, until rolled-steel sheets became available.

As noted in the *Mechanic's Magazine* for December, 1864, Whitley and Bower, in England, applied the process of centrifugal casting to the manufacture of cast-iron wheel tires. Their machine is shown in Fig. 1,[1] where *A* is a metal, clay-coated mold rotating about a vertical axis *B*. The metal is supplied through spout *C*, while *D* and *E* are the fast and loose pulleys by means of which the rotary motion is imparted to the mold. In its essential features the Whitley machine does not differ from the majority of those used today, at times under the veil of the deepest secrecy, in this country and elsewhere.

That the art of making centrifugal castings was known in the United States at an early date—that is to say, early in our industrial history—is shown very clearly by an illustrated description in one of the first issues of the *Scientific American*. Fig. 2 reproduces this page and the description, which exhibits the state of the art so well that comment is superfluous.

Sir Henry Bessemer, the inventor of the bessemer process of steel manufacture, devoted a good deal of his attention to the subject of centrifugal casting of steel, without, however, publishing full details of his trials. M. Tresca, in a paper before the Institution of Mechanical Engineers (1867, pp. 149-50), states, however, that "the most remarkable instance that he had met with of freedom from air bubbles was in the case of a bessemer rail manufactured at the Imphy Iron Works, near Nevers, in the Department of Nièvre; and he had ascertained that the method adopted at these works was to pour the molten metal into a revolving vessel driven at a considerable speed, so as to clear the steel of air by rapid rotation. This method appeared very effective in practice, in freeing the steel from the minute air bubbles which it contained on leaving the converting vessel or the melting pot."

In 1882 Webb, speaking before the Iron and Steel Institute (*Journal*, 1882, p. 522), stated that at his works in Crewe he was casting steel wheels and making them sound by casting them on turntables. Not only this, but he used a variable speed and feed in doing so. His remarks show that at that time the mechanics of the centrifugal casting process was already perfectly well understood, a supposition further supported by the fact that Ledebur's "Handbook of Iron and Steel Founding," published in 1892, devotes a chapter to centrifugal casting, covering all the fundamental elements of this art.

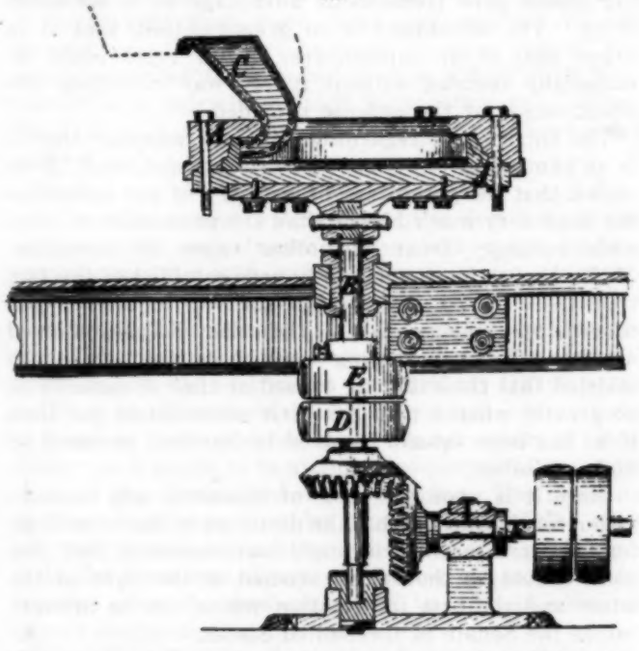


FIG. 1—WHITLEY AND BOWER (1864) MACHINE FOR CENTRIFUGALLY CASTING TIRES FOR WHEELS

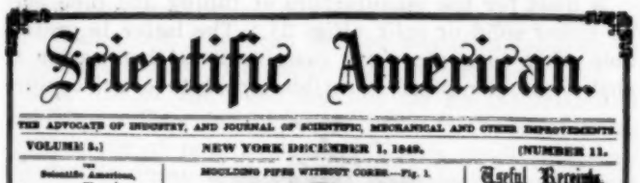
A study of these references and the numerous patents issued on centrifugal casting in this country and in Europe would indicate that practically all the essential features were covered by patents issued prior to the beginning of the twentieth century, so that with the exception of minor details and one or two features in special casting processes there is no reason why any good engineer could not design a successful casting machine without running into legal complications. A

[1] Reproduced from *Dingler's Polytechnic Journal*, vol. 153, p. 451.

familiarity with the patent situation is, however, desirable in order to avoid involuntary infringement by using some minor detail (such as, for instance, a particular type of pouring spout) that has been covered by a patent.

Field of Application

It is only within the last few years that the field of application of centrifugal casting has begun to be realized. As a matter of fact, it is very extensive indeed and falls into several regions. In the first place, centrifugal casting is a cheap method of producing goods of certain shapes—namely, those having a hollow interior, symmetrical about an axis passing through the body of the casting, whether concentrically or eccentrically. The advantage of such methods lies in the fact that with proper equipment a very large number of units can be produced with comparatively little labor and without the use of cores. During the war several concerns employed this method—for example, for the production of piston rings for automobile engines—and even now establishments like the Ford Motor Co. employ it regularly with considerable success. An American manufacturer of bearings uses the centrifugal method to line the tube with the bearing metal. The Sandusky Foundry & Machine Co., Sandusky, Ohio, employs such casting to produce big paper mill rolls and propeller sleeves which would be much more expensive and probably less satisfactory if cast in a stationary mold. The same method with slight modifications has been applied to the manufacture of hollow tubes of variable cross-section, which could not be cast at all in a stationary mold and would be very expensive to produce by machining.



Scientific American.

THE ADVOCATE OF INDUSTRY, AND JOURNAL OF SCIENTIFIC, MECHANICAL AND OTHER IMPROVEMENTS.

VOLUME 5.] NEW YORK DECEMBER 1, 1849. [NUMBER 11.

MOULDING PIPES WITHOUT CORES.—Fig. 1.

Useful Receipts.

Rail Road News.

FIG. 2—A PAGE OF THE "SCIENTIFIC AMERICAN" OF 1849

However, the above is not the most important field of application of centrifugal casting, the value of which lies primarily in the fact that by its means shapes can be produced which it would be next to impossible to produce by casting in stationary molds. Thus the Stokes Castings Co., Ltd., Mansfield, England, has produced by this method cast-iron liners for aluminum cylinders for airplane engines of such a small thickness and high grade of metal as could not be duplicated by any other process except by machining, and at a price only a small fraction of what a machined tube would have cost.

As a matter of fact, centrifugal casting in many cases produces a metal essentially different from the one produced by casting in a stationary mold, whether sand or chill, and approximates more the character of a forging. Thus tests made on centrifugal steel castings by Dr. G. K. Burgess, of the U. S. Bureau of Standards, have shown that centrifugal castings properly heat-treated can pass with a safe margin all requirements of the Ordnance Department specifications for gun forgings, which is certainly a very remarkable thing. Those who deal with thin-wall Monel metal castings know how extremely difficult it is to obtain solid metal free from blowholes and miniature "pipes" or cavities caused by unequal contraction. And yet Monel metal tubes 2 to 3 ft. in length and $\frac{1}{8}$ in. in wall thickness have been produced centrifugally of such uniformity of metal as to permit drawing them into perfect seamless tubes.

Centrifugal Casting vs. Piercing

Hitherto the principal tonnage of seamless tubing has been made by the Mannesman piercing process and its variations. Essentially this process consists in imparting such a twisting motion to a steel billet as to break down its central fibers, a motion set up by means of obliquely placed rolls or disks. This works very well with high-grade mild steel or Muntz metal, but does not work well with metals which are either extremely tough or very brittle. Thus all efforts to produce pierced Monel metal or Admiralty brass billets have so far been unsuccessful commercially. Because of this limitation of the Mannesman process there are a considerable number of metals and alloys not used today for the production of seamless tubing. Notwithstanding the large demand for high-carbon chromium (1.25 C, 1.5 Cr) steel for ball-bearing races and the fact that it would be obviously desirable to make these races out of seamless tubing, they are made out of a solid bar, either by direct machining or by the trepanning process, at a considerable increase in cost over what it would have cost to make them out of tubing. The reason for it is that high-carbon chromium steel of the above analysis cannot be pierced by the Mannesman process easily enough to permit of its commercial production. Not only that, but Mannesman's process is limited to the production of comparatively small sizes, not in excess of, say, 6 in. in diameter (although tubes as large as 9 in. have been produced more or less experimentally). It is obvious that as we go up in sizes both the piercing mills and the drawing benches used in this process increase in size and cost with great rapidity.

The centrifugal process permits one to cast, at a comparatively moderate cost, seamless tubes in sizes

practically without limit. For example, there is no reason except our still insufficient knowledge of the details of the process why tubes 10 ft. in diameter and, say, ½ in. wall could not be made thus.

It has particular application to the production of condenser tubing from Admiralty brass (10 per cent Cu, 29 per cent Zn, 1 per cent Sn). Hollow billets from this mixture cannot be made by the Mannesman process and therefore have to be cast in sand using a core soft enough to permit the metal to contract. Not only does this necessitate the use of excessively thick walls (⅛ in.) in order to produce a good casting, but such thick walls also require an excessive number of draws in the bench, with a corresponding increase in the cost of the final product. Furthermore, one can never be certain of the behavior of a soft core and no two castings are absolutely alike, some of them containing blowholes, cavities or hard metal. Moreover, in sand casting there is no positive way to eliminate slag inclusions or bits of sand from the mold or core being captured by the metal. Every blowhole, cavity or slag inclusion means a weakness or failure of the tubing, and none of them can be discovered as a rule until a number of draws have been made on the tube and a considerable amount of money and labor spent. Centrifugal casting in a mold with properly controlled temperature permits one to produce practically perfect Admiralty brass tubes in thicknesses of ⅜ in. and down to 1/16 in. with a higher degree of certainty than from sand-cast tubes. Moreover, such tubes have been found to be practically free from occluded slag or hard spots.

Another remarkable feature of centrifugal casting is its ability to produce very close mixtures where sand casting results in a great deal of segregation. One of the most striking examples of it is in the casting of lead-copper alloys. When cast in a sand mold the copper segregates from the lead to such an extent that the two metals can be clearly distinguished in yellow and dark gray banding. When cast centrifugally at proper temperatures a uniform blackish gray alloy is produced and the particles of copper and lead cannot be seen by the naked eye (but are fairly clearly distinguishable under a microscope). On the other hand, when casting bronze in a spinning mold, there does occur a certain degree of segregation resulting in an increase of hardness with a corresponding percentage of tin toward the inner edge. It would appear, therefore, that the action of centrifugal force affects some metals more than others, which may be due either to the electrical potential between the two metals or to the method by which the metals in the alloy are combined—that is, whether they form a chemical compound, a solid solution or a mechanical mixture—and possibly by the proximity of the analysis to the eutectic. It may be mentioned in this connection that all attempts to separate silver out of a lead-silver alloy by centrifuging have failed, notwithstanding very high speeds employed.

Mechanics of Centrifugal Casting

In the first place, clear distinction should be made between castings made with a horizontal and a vertical axis, and also with the intermediate case of an inclined axis. In casting about a horizontal axis the metal is distributed symmetrically about the axis, and if the axis of rotation coincides with the axis of the spinning unit, a tube of uniform thickness is produced for the entire length of the mold. If a vertical axis is used, it is obvious that the external wall of the casting follows the shape of the mold, while the interior of the casting forms a paraboloid of revolution, the elements of which, in accordance with the formulas developed by Resal and Kirpicheff, depend on the speed of rotation, the specific gravity of the metal and the depth of the mold. In casting with an inclined axis, the same general principles apply with the further complication that the elements of the inside paraboloid of revolution are also affected by the angle of inclination of the axis to the true horizontal.

Two methods may be used in producing centrifugal castings. The one ordinarily used is to introduce

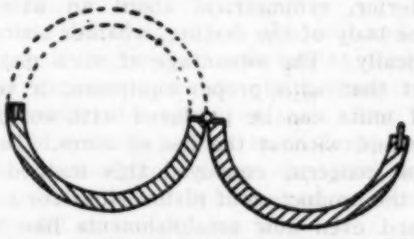


FIG. 3—SECTION OF MOLD SPLIT ALONG THE LONGITUDINAL AXIS (THE TWO PARTS MAY BE EITHER HINGED OR BOLTED)

molten metal into the moving mold. The other is to melt the metal in the mold in which the casting is made. While this is a convenient scheme to effect certain conditions—as when it is desired to keep the metal from coming in contact with air—it has been so far applied only on a limited scale.[2]

A mold for the manufacture of tubing and pipe may be either solid or split (Fig. 3). The latter is preferable when long pipes are cast, as it is then easier to shake out the pipe. Crucible graphite or zirconium

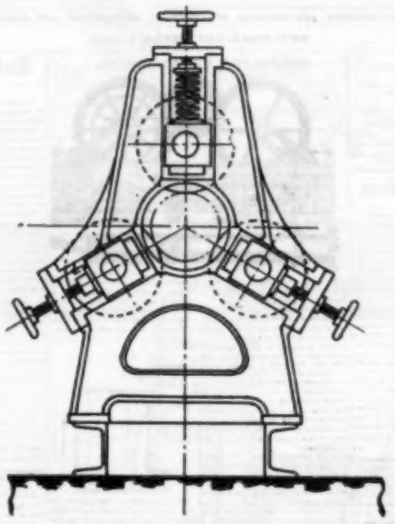


FIG. 4—SPINNING BENCH FOR USE WITH REMOVABLE MOLD

tubes may be used for molds for short castings, but when casting long pipe, metal molds are to be preferred, especially those made of such a heat-resisting and noncorrosive alloy as nichrome. Enough work has been already done on the production of cast tungsten to make it certain that a mold of this truly wonderful material will be available within a comparatively short time.

There are several ways of supporting the mold in the spinning bench (Fig. 4), the selection of which de-

[2] For its description see "Mold Serves as Electric Furnace," by E. C. Kreutzberg, *Iron Trade Review*, July 7, 1921.

pends mainly on the size of the unit. But there is one rule which must not be forgotten for an instant by the designer of a machine for centrifugal casting, and that is that it should be made substantial, strong and free from vibration, which means a well-balanced rotator on a solid foundation.

If molten metal is to be poured into the spinning mold, very careful consideration of the thermal conditions in the mold and of proper appliances for handling the hot metal will be required. It may be added that one of the most important reasons why centrifugal casting has not been used to the great extent which it deserves has been the failure to appreciate properly the necessity of keeping the mold at the *proper* temperature, be it high or low, and the consequent failure to produce sound articles.

Heating the mold may be done electrically if very cheap current is available. Otherwise the mold is heated in the same type of furnace as is now used for heating billets at tube mills, while small molds may be heated by placing them in the flue of a reverberatory furnace. For casting such metals as steel and Monel, the mold should be heated to about 2,200 deg. F., so as to reach the spinning bench with a temperature of about 2,000 deg. F.

Where a metal mold is used, it should be coated with a thin film of some material which prevents the metal of the casting from coming into direct contact with the metal of the mold. There are several materials that may be used for such coating, and their selection depends largely upon the metal to be cast. I may mention here electrically calcined magnesia with pitch as a binder; zirconia with either pitch or crucible clay as a binder; and plain pitch, which can be used only with non-ferrous materials except with alloys rich in nickel.

The life of the mold depends on its material and handling. Thus far nichrome appears the most long-lived material now available. Under conditions very similar to those under which these molds work, cast nichrome has shown a life of from 10,000 to 12,000 hours, the time required to make about 20,000 castings. Under certain conditions it may be found cheaper to use alloy iron molds with nichrome liners. If the outer shell of the mold is made of iron containing about 7 to 10 per cent Cr and 2 per cent Ni, the life of the mold will be as high as 1,000 castings. Selection of the type of mold is determined largely by considerations of cost and the heating furnace available.

Function of Riser or Sink-Head

We should consider first steel or Monel metal castings, since they present more difficult combinations of conditions than either brass or bronze. In making castings in a stationary mold, whether it be a simple ingot or a complicated casting from pattern, the foundryman has to provide for the escape of gas from the metal and for the piping produced by contractions in cooling. In a casting from a pattern, the gates or risers are so proportioned as to avoid defects from these causes. In ingot casting, special methods such as dozzling are used to keep the top of the ingot hot as long as possible and thus provide opportunity for the escape of gases, and furnish hot metal to fill in the contraction cavities, the topmost part of the ingot thus performing the functions of the risers in sand molds. In both cases the foundryman is prepared to discard as defective a certain part of the casting (the ingot head, gates and risers) and his skill lies partly in reducing the quantity of defective parts as far as possible, and especially in directing the process so as to get all the defective metal into the parts which he can discard without spoiling the casting.

In centrifugal casting, however, there is no riser or anything corresponding to the ingot top, the cooling proceeding essentially at a uniform rate all along the length of the tubular shape. It is obvious, especially in tubes of small diameter and considerable length, such as 6 in. outside diameter and 16 ft. long, that the loss of heat inward must be extremely small, because the entire inner air cylinder is surrounded by metal at approximately the same temperature. Heat is therefore lost outward to the mold and through it to the air. As a result of this, the part of the casting in immediate contact with the mold chills first. At first sight, especially to those familiar with such centrifugal processes as cream separation, it would appear that the pure metal, being heavier than either slag or oxidized metal, should be thrown to the outside, while all impurities and metal containing dissolved gases would be forced to the inside. This does actually happen, providing only sufficient time is available. But this separation takes place at a fairly slow rate because of the great viscosity of molten steel. If enough time is available between the instant of casting and that of complete freezing of the metal, the impurities and gases *will* be thrown out to the inside of the casting, otherwise they will be caught in the tube wall and make the tube worthless. This is one of the reasons of the many past failures to produce thin-wall steel tubing by centrifugal casting. On the other hand, very excellent steel tubes (both plain carbon and nickel alloy) have been produced with diameters ranging from 10 in. up and wall thicknesses up to 3½ in. In the latter case there is so much metal in comparison with the area in contact with the mold that enough time is available to produce a good segregation of impurities inward before the inner wall freezes.

Thermal Conditions in the Mold

It would appear, therefore, that the secret of producing tubing of thin-metal (under ½ in.) lies in establishing conditions under which the cooling of the molten metal would proceed at a fairly slow rate. In the Cammen process this has been accomplished by preheating the mold to a temperature fairly close to the melting point of the metal itself, as, for example, to 2,000 deg. F. for steel and Monel metal castings. Under these conditions a ⅛-in. wall takes about 60 seconds to harden entirely, which is sufficient to produce clean metal.

Brass casting shows the same phenomena, though, of course, to a somewhat lesser degree, because of the lower melting point of the metals and the ability to superheat them to a somewhat greater extent than is possible with steel. Nevertheless, even there the chilling of the metal is one of the most serious difficulties that has to be overcome by the manufacturer of centrifugal castings. Attempts have been made by several manufacturers to introduce the entire metal of the casting at once, which involves the use of elaborate and so far only moderately successful pouring devices.

The problem of the centrifugal tube maker working in bronze is somewhat complicated by the fact that he is between the devil and the deep sea, and cannot even directly resort to the Cammen expedient which proved satisfactory with steel and Monel metal—that is, the use of the hot mold. If he chills the bronze very

rapidly, he generally gets an excellent metal, but is apt to run into trouble because of the presence of blowholes due to occluded gases. Unless the metal is poured into the mold at such a rate as to form a complete section when casting heavy tubes by this process, the first metal poured chills, and then when new metal is added it does not weld completely to the previous batch, the result being a composite tube or one with split areas in its interior. These defective tubes give considerable trouble, especially under a hydrostatic test. This is probably the main reason why manufacturers of centrifugally cast bronze tubes refuse to sell rough castings; not being certain of their product, they prefer to eliminate defective tubes in their own plants rather than have their customers do it. On the other hand, if the maker chills the metal very slowly, using a hot mold, he gets rid of the danger of blowholes, but the bronze is coarse grained and will not satisfactorily pass the hydrostatic test. In the Cammen process this dilemma has been solved by the employment of a somewhat complicated but effective system. The bronze is poured against a hot mold (electrically heated to a temperature about 100 deg. below the melting point of the particular bronze), but as soon as the pouring has been completed a stream of water is passed over the mold, which chills it as rapidly as may be desired. In this way the temperature conditions during cooling can be controlled to accord with the best practice for the given metal.

Cast-Iron Pipe

Cast iron is in many respects different from that of the other metals, in that numerous tests have shown that the best results are obtained when cast iron is cast against a chill mold. Methods for making cast-iron pipe in rotating permanent molds have been developed by a French-Brazilian engineer, Dimitri Sensaud de Lavaud, whose work has been of pioneering importance. The method developed by de Lavaud is novel and ingenious. He uses a cast-iron mold, water cooled on the outside, and a pouring spout extending to the farther end of the mold and moving at a predetermined rate of speed outward. As the metal is poured, it chills almost instantly and by the time the spout is withdrawn the entire tube is formed. As the metal is cast against a chill, it is a quite brittle white iron, but after a proper anneal it becomes tough. Because of its great uniformity, centrifugally cast pipe may be a good deal thinner for the same strength than pipe cast in sand molds, the ratio being approximately 15 to 23 lb. per ft. in favor of the centrifugally cast pipe.

Stokes Castings, Ltd., developed another ingenious method of rapidly chilling the cast iron for making piston rings and liners for aluminum cylinders of airplane engines. This concern uses a mold composed of a cast-iron liner with a heavy aluminum jacket, the selection of aluminum being apparently due to the fact that it has a specific heat more than four times that of cast iron and also a higher coefficient of radiation.

Steel Pipe and Centrifugal Casting

The field of national importance which is apt to be profoundly affected by the development of centrifugal casting is that of steel pipe, whether welded or seamless.

In the last 10 years or so there has been a remarkable extension in the applications of pipe. It is now used as a starting point in the production of a great many types of mechanical elements, such as shafts and columns. While similar members made of bar stock are usually produced in alloy steels, such as nickel, chromium-nickel, chromium-nickel-vanadium and tungsten, the same members when made of piping are of plain carbon steel. The reason for this is that piping is available only in simple steels. Although alloy steel tubing can be produced by the Mannesman process in a more or less experimental manner, and in fact has been produced on a comparatively small scale by the National Tube Co. in this country and Accles, Pollock & Co. in England, it has not yet really become a commercial product, and has seldom been specified by designing engineers. The initial difficulty in the production of this tubing lies in the piercing process. But hollow billets can be easily produced by centrifugal casting at a cost which compares not unfavorably with that of piercing, and the subsequent drawing from a hollow billet is easier than from a pierced billet, since the former is made of metal which has not been strained beyond its elastic limit.

A still more important future development will be centrifugally cast pipe in sizes from 6 in. up. While such sizes can and actually have been made in seamless tube, the machinery and processes employed for these sizes are so expensive as to make it impossible to compete with welded pipe except in very special instances. Because of this, welded pipe from about 6 in. up, and riveted pipe in still larger sizes, is practically standard. Casting in a hot spinning mold permits the production of pipe in all sizes at a cost estimated to be in the neighborhood of $40 per ton for standard thicknesses, and down to $35 or possibly less for extra strong and double extra strong. That seamless pipe at this price is preferable to welded pipe for the majority of applications need hardly be proved. If it is remembered that the cost of a plant per ton of produce to make centrifugally cast pipe is very much lower than that of either seamless or welded pipe, it will be clear what effect the new process may have on an industry now producing close to 3½ million tons of steel goods.

New York City.

Prices of Portland Cement in 1921

Preliminary estimates made by the United States Geological Survey from reports of representative producers of portland cement show that the average factory price per barrel of portland cement, excluding cost of container, in the United States in 1921 was approximately $1.87. The prices by districts were as follows:

District	Average Factory Price per Bbl.
Eastern Pennsylvania and New Jersey	$1.72
New York	1.90
Michigan and northeastern Indiana	1.85
Illinois and remainder of Indiana	1.68
Western Pennsylvania and Ohio	1.73
Maryland, Kentucky, Virginia and West Virginia	1.83
Alabama, Tennessee and Georgia	1.94
Iowa, Minnesota and Missouri	1.77
Kansas, Nebraska, Oklahoma and Texas	2.15
Colorado and Utah	2.33
California	2.35
Washington, Montana and Oregon	2.51

New High Explosive Reported

A new high explosive called brazilite is reported to have been discovered in Brazil. In experiments this explosive resisted without deflagration all mechanical and chemical tests. Assistant Trade Commissioner Bernard H. Noll in the Feb. 6, 1922, issue of *Commerce Reports* states that it is claimed that the explosive does not give off gases prejudicial to the operator. During the experiments 5,650 g. was placed in a bored hole 4 m. 65 cm. in depth, and this charge, when detonated, displaced 200 cu.m. of granite.

The German and American Synthetic-Ammonia Plants*—III

Description of Processes and Apparatus Used at Oppau, Germany, and Sheffield, Ala., for the Removal of Carbon Dioxide and Carbon Monoxide and the Additional Purification of the Gases Required for the Ammonia Synthesis

BY R. S. TOUR

THE first undesirable constituent to be removed from the converted gas is the carbon dioxide, which is eliminated by water scrubbing of the gas under pressure. The pressure used at Oppau is but 25 atmospheres for the water scrubbing, although 200 atmospheres is the pressure used throughout the rest of the process. The compression is accomplished by 12 five-stage compressors (3-9-25-70-200 atmos.). After the third stage the gas is withdrawn and scrubbed, and then returned to the fourth and fifth stages. The compressors require about 1,000 hp. each, and are separately driven by direct-connected producer-gas engines. The compressors are of standard design with equal capacities in all stages, but since water scrubbing after the third stage removes about 35 per cent of the gas (CO_2 and some H_2 and N_2) there are provided 5 additional three-stage (25 atmos.) compressors to handle the larger capacity necessary in the power stages before water scrubbing.

CARBON DIOXIDE REMOVAL AT OPPAU

There are 12 water-scrubbing towers, 4 ft. in outside diameter and 40 ft. tall, made in two 20-ft. sections, bolted together in the middle. All operate in parallel, taking compressed gas from a manifold fed by the 17 compressors previously described. The gas passes up through the tower packing, consisting of Raschig stoneware rings (3 in. by 3 in.) while water flows downward through the packing to a reservoir at the base of the tower. The exit gas from each scrubber passes through a mist trap or catch-pot before passing on to the fourth stage of the 12 high-pressure compressors. The mist trap is bottle-shaped, 5 or 6 ft. long, with the gas inlet tube extending some distance down into the bottle. (See Fig. 6.)

At normal capacity, about 3,000,000 cubic feet per day of scrubbing water is pumped to the 12 towers by 6 centrifugal pumps direct connected to motors (180 kw., 1,480 r.p.m.). On the same shaft is connected a Pelton-type water wheel through which the exit water from the towers discharges and returns about 60 per cent of the input water; the motors furnish the difference. Each pump and water-wheel set serves two towers, although there is a manifold cross-connecting all sets. The water feed to the Pelton wheel is controlled manually with the aid of a sight gage which indicates the level of water in the tower. Automatic float chambers for maintaining the proper water level and rate of discharge have recently been developed. The carbon-dioxide gas released in the water wheels passes to a holder for use in the ammonia utilization processes.

The gases liberated from the discharge water represent nearly all of the carbon dioxide in the original gas; the scrubbed gas carries less than one per cent. All of the hydrogen sulphide and similar constituents are also removed. The solubility of the other gases is not negligible and experience at Oppau indicates that 7 to 8 volumes of hydrogen and nitrogen are dissolved while removing the 28 to 29 volumes of carbon dioxide. This absorption of hydrogen and nitrogen is about twice that called for by the available data on relative solubilities, but is in accordance with experience at Sheffield. It is interesting to note that the loss of hydrogen and nitrogen in the water is rather independent of the pressure at which the scrubbing is done, since the ratio of solubilities of the gases is not greatly affected by pressure.

CARBON-DIOXIDE REMOVAL AT SHEFFIELD

Carbon dioxide was absorbed at Sheffield at 100 atmospheres pressure, which was the pressure maintained throughout the rest of the process. The compression was accomplished in the operating unit by one (and one spare) 4-stage compressor (4-12-35-100 atmos.) with 700 cu.ft. per minute low pressure displacement. After allowing for water vapor in the gas, normal gas losses in scrubbing and purification, later "purge" of gas in the circulating system, and unavoidable but expected leakage, this displacement has a capacity of but 5 tons of ammonia per day. The compressors were belt driven by 300 hp. motors and operated very satisfactorily.

The original plan and installation was for water scrubbing the gas in three stages, the gas passing up through each of the three towers consecutively while fresh water was pumped to the top of each tower, fed downward through the packing, and was discharged into a common manifold. Such an arrangement for 3-stage scrubbing is fundamentally inefficient. It is evident that the water in the first tower will dissolve

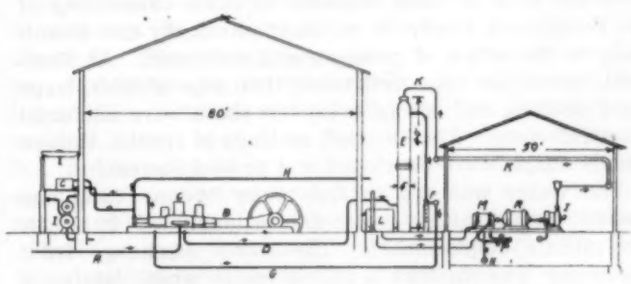


FIG. 6. COMPRESSORS AND WATER SCRUBBER AT OPPAU

A—Compressor intake.
B—5-stage compressor.
C—Intercoolers.
D—Compressor exit 3rd stage.
E—Water scrubbers.
F—Mist trap.
G—Return of gas to 4th stage.
H—Gas exit 5th stage.
I—Boilers on gas engine exhaust.
J—Centrifugal pump.
K—Water inlet to scrubbers.
L—Reservoir on water exit.
M—Pelton wheel power recovery.
N—Water discharge from Pelton.
P—Released CO_2 exit.
R—Motor for pumps.

*For Parts I and II see CHEMICAL & METALLURGICAL ENGINEERING, vol. 26, Nos. 6 and 7, pp. 245 and 307, Feb. 8 and 15, 1922.

carbon dioxide with a maximum solubility corresponding to the initial partial pressure. The unit absorption capacity of the water in the second tower will then be decreased due to the decreased partial pressure of carbon dioxide and finally in the third tower the solubility coefficient will be very low. In other words, at a given total pressure the quantity of water necessary to dissolve a given weight of carbon dioxide increases with any decrease in the percentage of carbon dioxide. Thus, if instead of absorbing the carbon dioxide in three stages, it were all absorbed in one tower of sufficient capacity, all of the water would be used under optimum conditions. The latter operation may require but half the water of the former, and in addition will proportionately decrease the loss of the valuable gases by solution in this water. The attempted operation at Sheffield also involved many mechanical difficulties in the control of the parallel water supply and discharge from each of the towers. After two months of experimentation two of the towers were superimposed, making one tower 2 ft. in inside diameter and 30 ft. high. One-stage scrubbing in this tower led to very satisfactory results, leaving less than one-tenth of 1 per cent of carbon dioxide in the gas. The exit gas passed through a catch pot to separate suspended water before passing to the next step of the process. (See Fig. 7.)

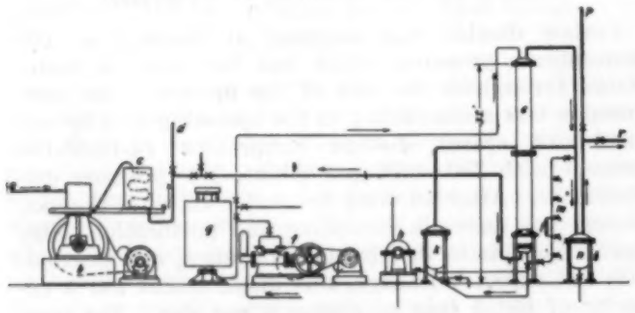


FIG. 7. COMPRESSORS AND WATER SCRUBBER AT SHEFFIELD

a—Compressor intake.
b—4-stage compressor.
c—Cooler.
d—Gas vent from system.
e—Water-scrubber tower.
f—Hydraulic pumps.
g—Accumulator.
h—Pelton wheel.
k—Float chamber.
l—Klinger gages.
m—Tell-tales.
n—Catch pot.
p—Gas vent from system.
r—Gas exit to caustic system.

The packing in the towers is of prime importance for efficient scrubbing, since it is essential that it affords much contact surface, causes turbulent flow of the gas, does not pack or mesh together to cause channeling of the fluids, and, finally, is resistant physically and chemically to the action of pressure and corrosion. At Sheffield, spiral tile were first tried, then pipe nipples, large hard pebbles, and special coke, but these were all found unsatisfactory. Finally small castings of special, though simple shape, were developed and proved successful.

The water was fed to the tower by one (and one spare) reciprocating motor-driven pump of 20 cu.ft. per minute displacement. The water discharge from the tower was through a Pelton water wheel driving a generator which fed into the power line. The water wheel operated on water at 1,500 lb. pressure and carrying about 20 volumes of dissolved gas. It was the source, therefore of much trouble; at its best it returned but 25 per cent of the power in the water. The carbon dioxide released was discharged to the roof, and the water passed to the sewer. No utilization of the carbon dioxide was considered.

The question as to what pressure should be used for water scrubbing is one to be decided according to the conditions at the plant concerned. The quantity of water handled, of course, decreases with increase of pressure, since the solubility of carbon dioxide increases. The power required to pump the water is, however, not much affected, since as the quantity decreases its pressure head increases. Power recovery from the discharge water is much improved at the lower pressures, the main difficulty at very high pressure being due to the high nozzle velocities and the large quantities of gas expanding out of solution in the nozzle. Further, all the power required to compress the carbon dioxide to the scrubber pressure is a loss which is reduced by decreased pressure. High pressure scrubbing decreases the size of the apparatus, since the volumes of gas and water are decreased proportionately while the velocity of absorption is increased. The advantage of smaller apparatus is, however, somewhat offset by the necessary increased strength of the vessels and joints. These considerations in general point to a comparatively low scrubbing pressure (i.e., 200 to 500 lb. per sq.in.).

Carbon-Monoxide Removal at Oppau

As previously stated, the exit gas from the 12 water scrubbers returns to the 12 high-pressure gas compressors and is compressed to 200 atmospheres. The balance of the process beyond this point operates at this pressure. The next step consists of scrubbing the gas with a copper solution; the gas passes through scrubbers similar in operation to the water scrubbers, but using ammoniacal cuprous formate solution (containing perhaps some carbonate) at ordinary temperatures as the dissolving medium. Refrigeration of the solution and absorption of the carbon monoxide at low temperatures has apparently been tried at Oppau and abandoned. There are 15 towers, arranged in two sets (of 7 and 8 each), and situated in one row along the outside of the compressor building. (See Fig. 8.) Any tower can be cut out and it is probable that one item in each set is a spare. The towers are steel forgings about 40 ft. high and 1½ ft. in inside diameter, with walls 5 in. thick. They are heterogenously packed with iron Raschig rings (1 by 2 in. in diameter). A mist trap, similar in construction to that used in the water scrubbers, is employed at the exit of each tower.

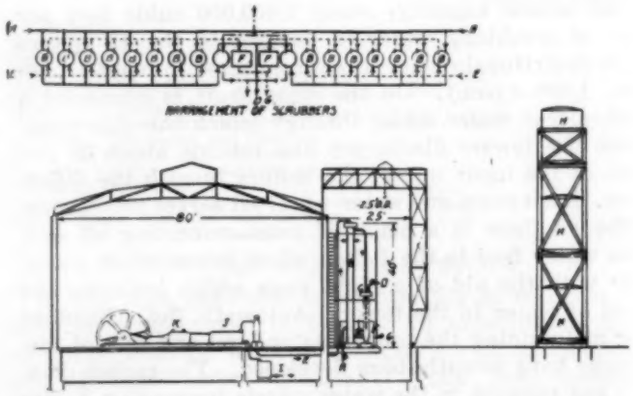


FIG. 8. COPPER SOLUTION SCRUBBERS AND PUMPS AT OPPAU

A—Gas inlet to scrubber.
B—Scrubbers for Cu solution. (See arrangement above.)
C—Mist trap.
D—Purified gas exit.
E—Cu solution exit from pump.
F—Pressure release tanks.
G—Cu solution to regenerators.
H—Regenerating tanks.
I—Cu solution inlet to pumps.
J—Cu solution pumps.
K—Steam engine cylinders.

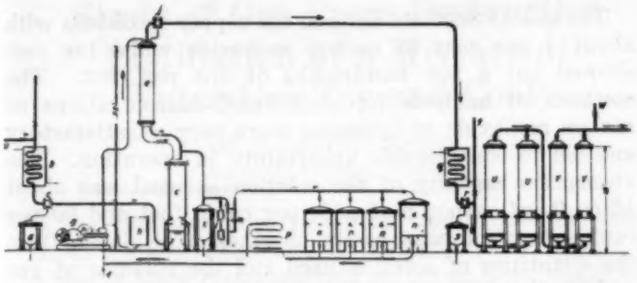


FIG. 9. COPPER SOLUTION SCRUBBERS AND DRIERS AT SHEFFIELD

a—Gas inlet from caustic system.
b—Cooler.
c—Separator.
d—Receiver.
e—Copper scrubbers.
f—Copper solution intake to pumps.
g—Copper solution pumps.
h—Accumulator.
j—Separator.
k—Float chamber.
l—Klinger gages.
m—Tell-tales.
n—Regenerating and storage tanks.
p—Cooling coils for copper solution.
q—Cooler.
r—Separator.
s—Receiver.
t—Gas vent from system.
u—Driers.
v—Purifiers.
w—Gas vent from system.
x—Gas exit to circulating system.

CONTROL OF THE COPPER-SOLUTION SCRUBBERS

All of the towers operate in parallel, the flow being manually controlled with the aid of sight gages. The gas inlets and exits of the scrubbers are cross-connected by a manifold and the operating valves are controlled from the inside of the building adjoining, the stems of the valves extending through the walls. There are friction orifices at the entrance of each tower for measuring the flow of gas, and the pressure differences are observed by means of a pressure balance of special construction. The device consists of a mercury U-tube of high pressure pipe, bent to a semicircle. This circle is suspended at its center on a knife edge with pressure connections of spiral flexible metal tubing leading from the center. A tendency to change the level of the mercury swings the U-tube and an adjustable counterweight about the knife edge. A pointer attached to the apparatus operates on a calibrated scale or a recording device.

The cuprous formate solution is pumped into the top of the scrubbers by 15 tandem-steam-driven pumps cross-connected in pairs (two pumps per flywheel). The solution passes from the bottom of the scrubbers to pressure release vessels, of which there are two, one for each set of towers. The spent solution, after release of the pressure, passes on to a large regenerating system where its carbon monoxide is removed by heating the solution under vacuum in regenerating vats, which are 20 ft. high and 16 ft. in diameter. The composition of the solution is readjusted before it is again used. The effluent gases from the generating system contain perhaps 50 per cent of carbon monoxide, the remainder being largely nitrogen, hydrogen, and ammonia. This mixture during the war was purified by additional ammoniacal copper solution and then piped to Ludwigshafen for the manufacture of phosgene, which was one of the most important of the poison gases.

Scrubbing the gas with the ammoniacal cuprous solution removes, by reaction with the reduced copper, any free oxygen that may be present; by combination with the free ammonia it removes the residual carbon dioxide as well as traces of other acidic gases that may have passed through the water scrubbers; and it absorbs nearly all of the 2 per cent of carbon monoxide in the gas. In normal operation about 35,000 cu.ft. per day of copper solution are passed through the towers, removing the carbon monoxide of the gas down to a few hundredths of one per cent. There is dissolved perhaps one per cent of the nitrogen and the hydrogen, which is liberated with the carbon monoxide on the regeneration of the solution. The absorption capacity of the solution for carbon monoxide is about 20 cu.ft. (60 deg. F. 30 in. Hg) per cu.ft. of solution, and regular operation approximates full saturation. There was, therefore, available at Oppau about 650,000 cu.ft. of carbon monoxide per day.

The question naturally arises why the copper scrubbing should be done at 200 instead of 25 atmospheres pressure. The mechanical construction would certainly be simpler for the latter. This case is different from that of the water scrubber. The power loss due to dissolved gas is slight and the energy requirement for the solution is small, so no attempt is made to recover the power. Further, the completeness and efficiency of purification is greatly improved by pressure and this is of paramount importance here. It must be remembered that the manufacturing and regenerating cost of the copper solution makes it desirable to use it in minimum quantities.

CARBON-MONOXIDE REMOVAL AT SHEFFIELD

The original plan at Sheffield was to remove most of the carbon monoxide by scrubbing with hot concentrated caustic solution (according to the reaction: $NaOH + CO = NaCOOH$) preliminary to the scrubbing with the cuprous solution. The equipment for hot-caustic scrubbing was necessarily very elaborate. A gas-fired tubular heater was installed for heating the gas before it came in contact with the hot caustic. The hot gas passed on to the "lift line," where, acting as an air-lift pump, it carried hot-caustic solution to the top of the scrubber down which the gas and caustic passed over cast-iron packing. The scrubber tower was kept hot by a hot-air jacket supplied by a special gas-fired furnace. The liquid and gas, descending to the bottom of the scrubber, separated in a caustic-solution reservoir; the gas passed out through water-cooled coils for condensing the moisture, which drained back to the caustic reservoir. The solution in the reservoir returned by gravity to the inlet of the lift line to repeat its cycle, but on the way passed through a gas-fired tubular furnace for reheating. For continuous operation partly spent solution was to be drawn from the reservoir, and fresh solution was to feed into the system through still another gas-fired furnace.

Since the hot-caustic scrubbing was finally abandoned it will not be necessary to discuss the principles involved. The intermittent trial runs proved that 75 per cent of the carbon monoxide could be removed by hot caustic. Cuprous-scrubbing is still required for the residual carbon monoxide, and the only net saving by hot caustic is the 75 per cent decrease in the circulation quantity of copper solution. It is doubtful whether hot-caustic scrubbing is economical even if its mechanical difficulties were overcome. The difficulties with the installation at Sheffield finally proved themselves insurmountable and after three months of untiring attempts, hot-caustic scrubbing was abandoned and the carbon monoxide allowed to pass on to the cuprous system for entire removal there. The caustic circulating and lift system, however, remained in service and although a cold solution was used it served to remove residual carbon dioxide, hydrogen sulphide, etc., after the water scrubbers.

Sheffield used cuprous ammonium carbonate instead of the formate for the absorption of carbon monoxide. There seems to be very little difference between the two as to absorptive power for carbon monoxide, but there is considerable advantage in using the formate when stability of the solution is taken into consideration. The carbonate as used at Sheffield gave much trouble in preparation, precipitated metallic copper while in use, broke down considerably on regeneration, and in general proved unsatisfactory.

Control of Cuprous Scrubbing at Sheffield

The original installation for cuprous scrubbing in Unit No. 1 consisted of one tower 2 ft. in inside diameter and 15 ft. tall. The solution was supplied to the top of the tower by a small piston pump drawing from the storage vats and feeding through a "reducing chamber" filled with metallic copper in order to make sure that all the copper in the solution was in a reduced state. It was soon found that the solution required no reduction in operation, the carbon monoxide in solution acting as a reducing agent on regeneration even after the solution had picked up considerable quantities of oxygen during scrubbing. Further, it was found that one tower afforded insufficient scrubbing and two were used, these being placed one above the other, though not directly superposed and so piped together as to operate as one long tower. (See Fig. 9.) The building and location of equipment did not permit setting up a single long tower. The gas passed upward through the towers and through a separator and catch-pot to entrap suspended liquid. The solution passed down the towers and out at the bottom, the discharge being controlled manually with the aid of sight gages, showing the level of liquid in the bottom of the tower. Automatic float chambers installed at Sheffield for controlling the discharge failed to function properly and no alternative from manual control was possible. In the redesign of the plant, an electrical device has been developed which tests indicate should operate very satisfactorily for the automatic control of the various liquid discharges throughout the process.

The copper solution was discharged directly through a line into the regenerating and storage tanks, where it was heated to 70 deg. C. at atmospheric pressure by steam coils and allowed to cool by radiation; no heat interchanger system was installed. Great care was taken in regeneration to avoid contamination of the solution by oxygen of the air. Heating this solution at atmospheric pressure was very destructive and required continuous readjustment of composition (especially the addition of ammonia).

Effect of Refrigeration

In view of the fact that refrigration of the gas for removal of moisture was to follow the copper system at Sheffield, a beneficial change was made during operation to bring part of the refrigeration into effect together with the copper scrubbing. The gas before entering the copper scrubber passed through coils cooled by refrigerated brine. The copper solution on the way to the pumps was also cooled by brine. Although refrigeration does not greatly increase the absorption capacity of the solution at saturation, it does decidedly decrease the carbon monoxide vapor pressure of the solution when it is but partially saturated. Thus, refrigeration does not materially decrease the quantity of solution to be used. but does improve the purity of the gas at the exit of the copper towers where it is in contact with fresh solution.

The gas at Sheffield entered the copper scrubbers with about 4 per cent of carbon monoxide while the exit showed but a few hundredths of one per cent. The methods of analysis for such small concentrations of carbon monoxide in hydrogen were very unsatisfactory and led to considerable uncertainty in operation. The absorption capacity of the solution as used was about 15 cu.ft. of carbon monoxide per cubic foot and 90 per cent saturation was easily obtained (calculated from the quantities of solution used and the volumes of gas scrubbed). The gas entering the scrubbers sometimes contained as much as 0.1 per cent of oxygen which was completely removed by the copper solution and taken care of by reduction during regeneration.

Additional Purification at Oppau

Following the copper scrubbers there are two caustic scrubbers, one in series for each set of parallel copper scrubbing towers. These two towers with mist traps are in the same row and identical in construction with the copper towers. About 3,500 cu.ft. of 30 deg. Bé. solution is circulated per day through the two scrubbers by means of two vertical duplex pumps with 40 hp. motors. It would seem that the caustic scrubber ordinarily aids little in purification but acts as a safety in the line in case the water scrubbers or copper scrubbers do not function properly. Partially spent caustic solution after release of pressure is handled by centrifugal pumps discharging to the final absorption tower of the nitric acid system.

This completes the purification steps in use at the Oppau plant. No precautions are taken to remove moisture, since, as we shall see, the ammonia synthesis system to which the gas passes directly from the caustic scrubbers utilizes water as the scrubbing medium to remove the ammonia from the gas. No steps are taken for removing the very small percentages of carbon monoxide and ammonia that are retained in the gas after leaving the scrubbers.

Additional Purification at Sheffield

It was necessary to dessicate the gas thoroughly at Sheffield in order to protect the particular type of ammonia catalyst selected for use there. This was accomplished by refrigeration followed by soda lime drying. For the former the gas passed through two sets of coils each submerged in a bath of refrigerated brine circulated by a small pump from an ammonia refrigerating system. In later operation, as previously noted, one of the brine coolers was reconnected to precede the copper system. The brine coolers worked very satisfactorily, the only care necessary being to avoid too low a temperature which might freeze the condensed moisture within the coils. The gas passed from the coolers through separators and then upwards through a tower, 15 ft. high and 2 ft. in inside diameter, filled with coarse soda lime. There were two such towers, one being a spare to be repacked while the other was in use.

A tower filled with a special purification material developed as a specific protection against poisons especially dangerous to the catalyst, followed the soda-lime towers. This completed the purification at Sheffield and the gas passed directly to the circulating system for ammonia synthesis.

The fourth installment of this article, in which the actual ammonia synthesis is described, will be published in a subsequent issue.

Study of Gas From Destructive Distillation of a Mixture of Water-Gas Tar and Coal*

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THE chemical properties of the unsaturated members of the aliphatic series of hydrocarbons are such as to render them ready starting points or basic materials for the synthesis of hundreds of important organic chemicals. The tremendous quantities of these unsaturated compounds that are produced daily in the various coal-carbonization and oil-refining processes and the fact that at present they have little value other than for fuel render a survey of the identity and extent of occurrence of these compounds important from the viewpoint of economic utilization and conservation of our natural resources. The increased need of liquid fuel and the relatively early exhaustion of petroleum resources will eventually require every utilization of liquid fuel products obtainable directly or indirectly from coal. Accordingly the Bureau of Mines has taken advantage of an opportunity[1] for making an examination of the gaseous unsaturated hydrocarbons found in the gas obtained when a mixture of water-gas tar and coal[2] is distilled in a gas-making retort. The results obtained are set forth briefly in the subsequent paragraphs.

Method of Procedure

The method[3] employed in general was to collect the unsaturated compounds in the form of their dibromide derivatives at the plant and to isolate the individual members of the mixture in the laboratory. During the collection the gas was drawn from the system after the tar and ammonia removal had been effected. It was then led in turn through NaOH solution and over solid NaOH for the removal of H_2S, through a large cartridge of activated gas-mask charcoal to remove oils and vapors, through a meter for rate and volume measurements and finally through a train for the absorption of unsaturated compounds. The train consisted of a series of three bottles containing a layer of bromine covered by a little water. Three such trains were used in parallel and were kept in a bath whose temperature was maintained at approximately 5 deg. C. Full cognizance was taken of the work of Read and Williams,[4] in which it was reported that when ethylene was passed into bromine water, approximately one-half the bromine, and consequently a proportional quantity of the ethylene absorbed, go to form the bromhydrin, while less than the remaining one-half forms ethylene dibromide. It has, however, been found experimentally as indicated by the theory that if the entering gas first comes into contact with the bromine as in bubbling through it, the amount of bromhydrin formed is negligible for the purpose in hand. The possibility of bromhydrin formation may be also avoided by omitting the water from the first bottle containing bromine. Most of the absorption of the unsaturated compounds occurs in the first bottle.

The total volume of gas passed was 40 cu.ft., and the average rate of flow through the apparatus was 7.2 liters per hour. The crude bromides produced and collected were washed with Na_2CO_3 solution and water and dried with $CaCl_2$.

Fractionation

A quantity of these crude bromine derivatives was fractionated under diminished pressure in an atmosphere of nitrogen. The distillation flask was heated by immersion in a liquid temperature bath, and the receiver was immersed in a freezing mixture. There was obtained, from 543 g. of crude material, three portions of the following characteristics:

Portion I—430 g., equivalent to 79 per cent, boiling below 60 deg. at 12 mm.

Portion II—14.5 g., or 2.7 per cent, boiling between 60 deg. at 12 mm. and 125 deg. at 35 mm. The evolution of HBr due to decomposition with consequent rise of pressure was evident and the distillation was stopped.

Portion III—94 g., or 17 per cent, of black tarry residue.

The fractionation of portion I after being thoroughly dried was first begun at atmospheric pressure, but evidences of decomposition appeared and it was continued under diminished pressure. The crude fractions corresponding roughly to the dibromides of ethylene, propylene and combined homologs were then fractionated in order at atmospheric pressure, using an 8-in. column. The final fractions were (*a*) 15 g. of boiling range 79 to 83 deg.; (*b*) 228 g. of boiling range 125 to 135 deg.; (*c*) 96.5 g. of boiling range 135 to 145 deg.; (*d*) 25.0 g. of boiling range 145 to 165 deg.; (*e*) 14.6 g. of boiling range 165 to 180 deg., and (*f*) a solid residue of 10.5 g., the loss of 40.4 g. of substance.

Physical Properties of Fractions

These fractions were then examined as to their physical properties. Fraction *a* boiling between 79 and 83 deg. was found to have at 20 deg. a specific gravity of 0.8858 (pure benzene $D\ 20/4 = 0.8799$), to contain only traces of bromine and to possess the characteristic odor of benzene. This fraction was therefore considered as benzene.

TABLE I

Material	Boiling Point, Deg. C.	Sp. Gr. at 20 Deg. C.	Bromine in Per Cent	Carbon in Per Cent	Hydrogen in Per Cent	Total
Ethylene dibromide....	131	2.178	85.07	12.78	2.16	100.11
Fraction *b*.....	125–135	1.982	81.10	16.70	2.71	100.5
Propylene dibromide...	141.6	1.933	79.17	17.84	2.99	100.0
Fraction *c*.....	135–145	1.942	79.40	17.83	2.89	100.1
Butylene dibromides...	148–166–158	1.79–1.82	74.03	22.24	3.73	100.0
Fraction *d*.....	145–165	1.760	71.77	24.76	3.61	100.14
Amylene dibromides...	170–190	1.60–1.70	69.51	.....	....	.....
Fraction *e*.....	165–180	1.629	63.3	.....	....	.....

The next four fractions—namely, *b*, *c*, *d* and *e*—were examined by determining the specific gravity, analyzing for bromine,[5] carbon and hydrogen. The results of these determinations are given in Table I, in which are placed,

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*Report of Investigations, U. S. Bureau of Mines.

[1] The Trent Process Corporation, Washington, D. C., was at that time carrying on, at the Georgetown Gas Works, distillations of "amalgams" prepared from various coals and oils by the Trent process for cleaning coals, and it was through the courtesy of the officials of that organization that the collection of the material for this examination was made possible.

[2] Kanawha gas coal (70 per cent) and water-gas tar (30 per cent) from the Washington Gas Light plant were used in the "amalgam" distilled at that time.

[3] See Norton and Andrews, *Am. Chem. J.*, vol. 8, p. 1; Zanetti, *J. Ind. Eng. Chem.*, vol. 8, pp. 676 and 679, 474; Sennatt and Slater, *Gas. Journ.*, 1920, p. 695, and others.

[4] *J. Chem. Soc.*, vol. 111, p. 240 (1917). Also Read and Hook, *ibid.*, vol. 117, p. 1214 (1920).

[5] Method of Carius was used.

for purpose of comparison, those same constants for the pure dibromides of ethylene, propylene, butylenes and amylenes.

Discussion of Results

In the case of fraction *b*, a first consideration of the specific gravity and the analyses seemed to indicate that this fraction was badly contaminated with propylene dibromide. However, repeated efforts to eliminate the latter by fractional distillation led to the conclusion that the impurity—material other than ethylene dibromide—must be a compound of lower bromine content and higher carbon and hydrogen content than ethylene dibromide, and yet with a boiling point quite close to that of the latter compound. Assuming the bromine content of this fraction to be present entirely as ethylene dibromide, the improbability of the impurity being a simple hydrocarbon is seen from the total nonconformity of the calculated specific gravity of such a mixture with the measured value of the fraction. A survey of the monobromine derivatives of the aliphatic and aromatic series of hydrocarbons led to the belief that monobrompentane (which has a boiling point 129 deg., $D\ 20/4 = 1.2234$, bromine content of 52.9 per cent, carbon content 39.7 per cent and hydrogen content of 7.35 per cent) might be the impurity provided it is formed under the conditions which obtained. Assuming monobrompentane to be the only impurity of consequence, simple algebraic calculations, based on the bromine and carbon content of brompentane and ethylene dibromide on the one hand and the values found by analysis for the fraction *b* on the other, indicated the same relative proportions in which the two compounds could be present. An approximate average of the two values showed 87.5 parts of ethylene dibromide and 12.5 of brompentane, and on that basis the calculated values for the hydrogen content and specific gravity agree with those found for the fraction. The values follow:

	Bromine Per Cent	Carbon Per Cent	Hydrogen Per Cent	*D*20/4
Calculated	81.05	16.2	2.81	1.984
Found for fraction b	81.10	16.7	2.71	1.982

More positive evidence of the presence and identity of the impurity was sought by causing a quantity of this fraction *b* to react,[5] in one experiment with a zinc-copper couple,[6] and in a second with an Al-Hg "Metallpaar," and[7] the resulting gas and vapor passed through a coil cooled to —10 deg., to remove alcohol and unreacted fraction *b* by condensation, and then through a coil cooled to —70 to —80 and finally into bromine cooled to 5 deg. In a catch bulb on the second coil a small quantity of liquid was obtained to which a little ice water was added and the bulb shaken. An upper layer of oil separated, which, when tested by the Menzies method for determining boiling points of small amounts, boiled from 32 to 35 deg. The ethylene dibromide recovered from the bromine in this experiment was found to be practically pure. Further work on the identification of the impurity under question being impossible through a lack of more of fraction *b*, the latter was considered to be 87.5 per cent of ethylene dibromide and about 12.5 per cent of material which the evidence seems to indicate to be a bromine derivative of pentane.[8]

[5] Gladstone and Tribe, *J. Chem. Soc.*, vol. 45, p. 154 (1884), *Ber.*, vol. 6, pp. 202, 454 and 1153 (1873).
[6] Wislicenus, *J. prakt. chem.*, vol. 54, p. 52 (1896).
[8] The constants and properties of $CH_3CH_2CH_2CBr:CH_2$ would permit it to be considered here in the same proportion. However, the agreement between the calculated specific gravity for such a mixture (1.942) and that found (1.982) is not so close.

In fraction *c*, in view of the conformity of its specific gravity, boiling range and composition with that of propylene dibromide, the fraction was considered to consist practically entirely of that compound.

In fraction *d* it is seen that other material than butylene dibromide (of which there are three isomers theoretically possible) must be present. As in fraction *b*, saturated hydrocarbons may be eliminated and among the monobromine derivatives that might be possible impurities, monobrombenzene and monobromhexane are the most likely. Calculations based on carbon and bromine content showed that approximately ten parts of either compound with 90 parts of butylene dibromide would give a mixture with properties similar to those of fraction *d*. On the other hand, a consideration of the specific gravity of the same two mixtures demands that the greater part of this impurity be monobrombenzene to have the same specific gravity as measured for fraction *d* (calculated 1.764, measured 1.760). In view of the fact that paradibrombenzene was isolated and identified in *e* and in portion II and that fraction *d* amounted to only 25 g. in all, it was considered that fraction *d* consisted of butylene dibromides containing 10 per cent of monobrombenzene.

TABLE II—HYDROCARBONS COLLECTED AS BROMIDE DERIVATIVES (469.5 g.)

		Grams
I.	Benzene	15.0
	Ethylene dibromide	200.0
	Monobrompentane	28.0
	Propylene dibromide	96.5
	Butylene dibromides	22.5
	Monobrombenzene	2.5
	Amylene dibromides	14.5
	Paradibrombenzene	3.0
II.	Paradibrombenzene	3.0
	Liquid dibrombenzenes	12.0
III.	Tetrabrombutane	25.5
	Liquid residue	62.0
	Carbon	6.5
	Total working loss	52.0

In view of the divergence of the constants of the isomeric amylene dibromides and the small total amount of fraction *e*, the latter was taken as an approximate measure of the amylenes and any further unsaturated compounds in the gas.

At the close of the fractionation in vacuo of portion I, there formed, as a sublimate of the residue *f*, monoclinic tablets perfect in form, entirely colorless, melting without recrystallization at 87 deg. From the final combined residue of portion I, paradibrombenzene was obtained and identified by its melting point (88 to 89 deg.) and its bromine content. Three grams was isolated by crystallization at low temperature.

From portion II, obtained in the first distillation, approximately 3 g. more of dibrombenzene was separated by crystallization. The residual mother liquor, 7.6 g., showed on analysis a bromine content of 69.99 per cent, whereas for dibrombenzene the theory demands 67.74 per cent. The specific gravity at 20 deg. was 1.954 and that for ortho- and meta-dibrombenzene is 1.977 and 1.965 respectively (at 18 deg.). This mother liquor was considered to be largely a mixture of dibrombenzene and no further attempts at isolation and identification of the constituents were made.

The residue (portion III) from the original distillation, as previously stated, was a black pitchy mass. The ethereal extract separated a dark liquid amounting to 87.5 g., which, on being well cooled, yielded 25.5 g. of tetrabrombutane (1, 2, 3, 4 derivative) which was identified by its melting point (115 to 116 deg.) and its bromine content. (Theory demands 85.53 per cent;

found, (*a*) 84.43 per cent, (*b*) 85.08 per cent.) The crystals were orthorhombic. No further products were isolated from the 62 g. of mother liquor. The ether extraction residue from III was 6.5 g. of carbon particles of less than micron size and resembling carbon black. They were a product of decomposition during distillation. The presence of the 1, 2, 3, 4 tetrabrombutane undoubtedly indicates the presence of 1–3 butadiene in the gas.

Thus the gas under examination contained in addition to condensable oils largely collected by the charcoal and those gases unaffected by the bromine (CO_2, 1.6 per cent; O_2, 0.5 per cent; CO, 5.3 per cent; H_2, 35.5 per cent; CH_4, 42.5 per cent; N_2, 6.6 per cent) the constituents—forming about 6 per cent of the total gas volume—which are grouped together in Table II in the form and quantity in which they were isolated.

The amounts of the unsaturated hydrocarbons in the gas calculated from the values just given are presented in Table III. In view of the present-day interest in one

TABLE III.

	Per 40 cu.ft. of gas			Per 1,000 cu.ft. of gas		
	Dibromides in Grams	Hydrocarbons In Grams	Theoretical Alcohol Equivalent In Grams	Hydrocarbons In Grams	Hydrocarbons In Cu.Ft. At 25 Deg.	Theoretical Alcohol Equivalent in Gallons
Ethylene	200.0	30.0	49.3	1230	23.10	0.415
Propylene	96.5	20.1	28.8	720	10.34	0.238
Butylene	22.5	5.85	7.7	193	2.25	0.063
Amylenes	14.5	4.42	5.6	139	1.36	0.045
Butadiene	25.5*	3.70	....	.....	.....	.....

*Represents that which was actually isolated as the tetra-brom derivative; the amount present would be larger.

utilization of olefine hydrocarbons from commercial-scale sources of production—namely, the production of their corresponding alcohols—the theoretical equivalents of the unsaturated hydrocarbons are included.

Summary

(1) The unsaturated hydrocarbons of the gas produced by distilling a water-gas tar and coal mixture in a gas retort were collected for study by removing them as their dibromide derivatives.

(2) The identity and approximate amounts of these unsaturated hydrocarbons have been determined.

(3) Most of the compounds contaminating the dibromides of these hydrocarbons have been identified.

Acknowledgment

The writer wishes to acknowledge the valuable suggestions and assistance of A. C. Fieldner, Supervising Chemist, and J. D. Davis, Assistant Supervising Chemist, of the Pittsburgh Station, and the courtesies of the officials of the Trent Process Corporation.

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Nitrogen in Oxyacetylene Welds

Analyses for nitrogen in oxyacetylene weld metal have been made by the Bureau of Standards on samples which are representative of two types of fracture—crystalline and fibrous. On the basis of combined nitrogen, there seems to be no distinction between the crystalline and fibrous weld metal. The limits of combined nitrogen found were approximately one-sixth the limiting values for nitrogen in electric arc deposited metal—that is, 0.015 to 0.027 per cent nitrogen in oxyacetylene welds, as compared with 0.10 to 0.15 per cent in the arc weld.

Graphic Record of Sulphuric-Acid Plant Operation

By E. B. Rupard

At the end of the fiscal year or other operating period it is customary to represent the efficiency of a sulphuric-acid plant by the average niter consumption, chamber space, production and other composite figures of the year's run. Although the actual efficiency is indicated, the figures cannot give an idea of the details of plant operation. If those interested in knowing how the yearly averages were obtained wish to follow the plant operation through the year, the daily, or at least weekly, plant records must be reviewed. This would be a tedious task and probably the conclusions would be vague because the average mind is unable to visualize operations from such a mass of data.

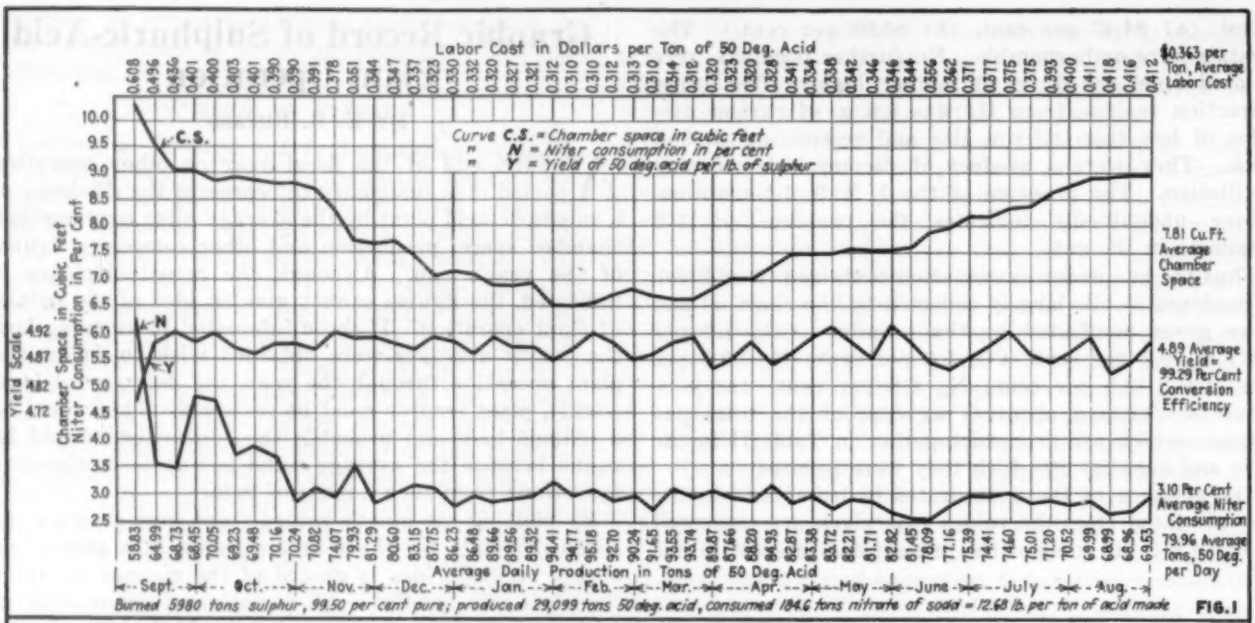
By plotting the plant's record from week to week the detailed results for the year are shown at a glance and a very accurate idea is gained of the manner in which the plant was handled. All variations from normal, as well as efficient running, are shown. If the plant is well managed, the niter and yield curves will show even trends, and on the other hand faulty operation will naturally cause wide variation with consequent poor results.

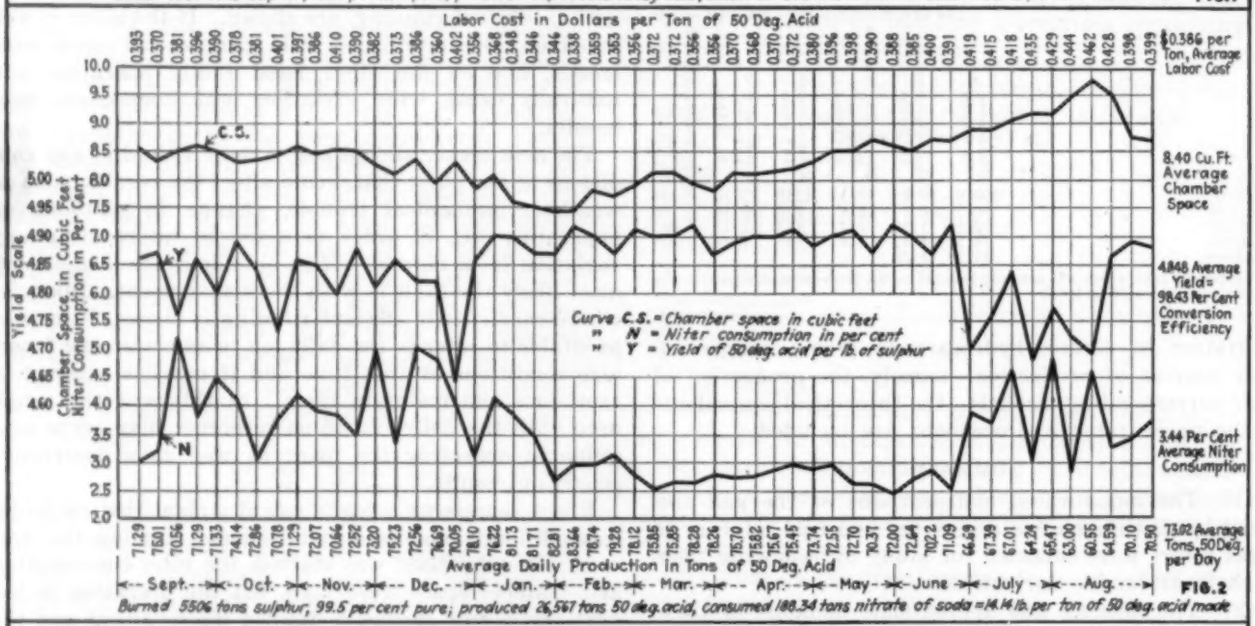
The acid maker should keep a daily record of any conditions at the plant that would affect the results, such as weather, mechanical trouble, change in methods or apparatus, etc., in order to assist in interpreting any variation from normal. If no outside cause is apparent, most likely the fault is with the management. Likewise where consistently efficient running is shown, it may be profitable to refer to the daily log to ascertain the favorable conditions at that time and if possible attempt to reproduce and maintain them. In this way the graph used with the daily record as reference may serve as a guide in operating the plant as well as a descriptive report on results.

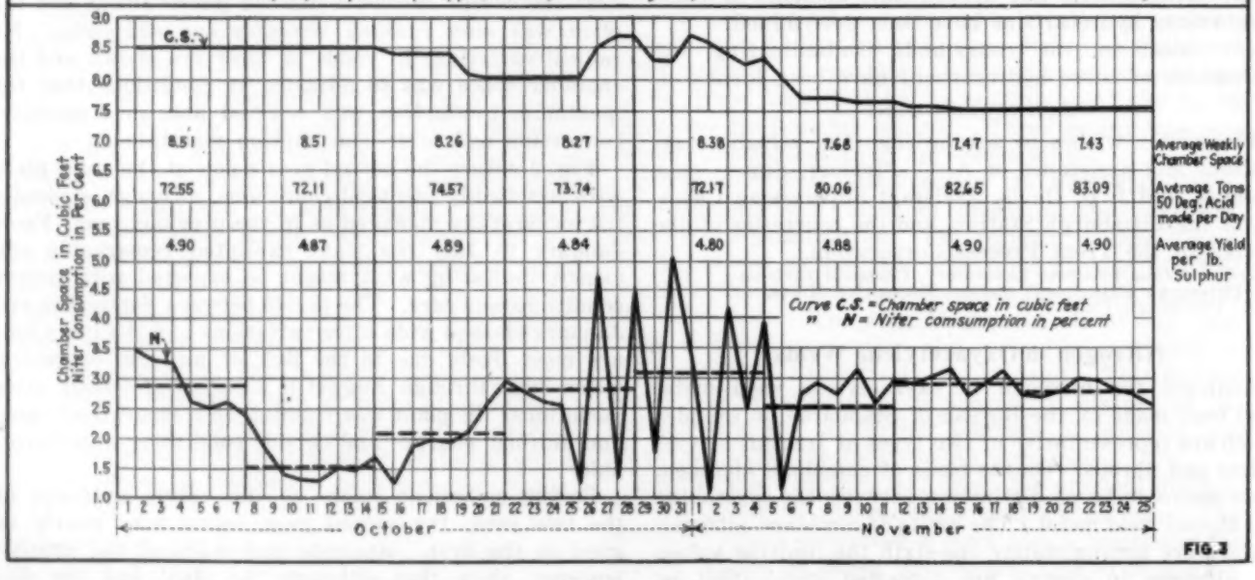
Fig. 1 represents a year's run at a plant that evidently was efficiently managed at all times. During the first week after the plant was started, the niter consumption and chamber space were high, but the operation in the next few weeks showed a decided improvement and the plant was soon running smoothly and efficiently. No radical variations in yields or niter are shown and the chamber space was so adjusted to conditions that the maximum production was realized and an economical conversion and niter consumption maintained.

Fig. 2 covers the second year's run at the same plant with practically identical conditions, although evidently not as carefully managed as in the previous year. From January to July the plant exhibited remarkable efficiency, indicating what might be expected with proper conditions and care. The period between September and January showed wide niter variations and the low yields are most likely due to the lack of uniform operation. From June through August is a period of weekly niter variations; the plant was running on comparatively easy and uniform charges and outside conditions were favorable.

Basing judgment solely on the yearly averages of the two runs, the second year seems very nearly as good as the first. Analysis and study of the graphs, however, show that although the plant had the disadvantage of starting up, the first year was really a great deal better than the second. During the second


Labor Cost in Dollars per Ton of 50 Deg. Acid
$0.343 per Ton, Average Labor Cost
Curve C.S. = Chamber space in cubic feet
" N = Niter consumption in per cent
" Y = Yield of 50 deg. acid per lb. of sulphur
7.81 Cu. Ft. Average Chamber Space
4.89 Average Yield = 99.29 Per Cent Conversion Efficiency
3.10 Per Cent Average Niter Consumption
79.96 Average Tons, 50 Deg. per Day
Yield Scale
Chamber Space in Cubic Feet
Niter Consumption in Per Cent
Average Daily Production in Tons of 50 Deg. Acid
Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug.
Burned 5980 tons sulphur, 99.50 per cent pure; produced 29,099 tons 50 deg. acid, consumed 184.6 tons nitrate of soda = 12.68 lb. per ton of acid made
FIG. 1


Labor Cost in Dollars per Ton of 50 Deg. Acid
$0.386 per Ton, Average Labor Cost
8.40 Cu. Ft. Average Chamber Space
4.848 Average Yield = 98.43 Per Cent Conversion Efficiency
3.44 Per Cent Average Niter Consumption
73.02 Average Tons, 50 Deg. per Day
Curve C.S. = Chamber space in cubic feet
" N = Niter consumption in per cent
" Y = Yield of 50 deg. acid per lb. of sulphur
Yield Scale
Chamber Space in Cubic Feet
Niter Consumption in Per Cent
Average Daily Production in Tons of 50 Deg. Acid
Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug.
Burned 5506 tons sulphur, 99.5 per cent pure; produced 26,567 tons 50 deg. acid, consumed 188.34 tons nitrate of soda = 14.14 lb. per ton of 50 deg. acid made
FIG. 2


Average Weekly Chamber Space
Average Tons 50 Deg. Acid made per Day
Average Yield per lb. Sulphur
Curve C.S. = Chamber space in cubic feet
" N = Niter consumption in per cent
Chamber Space in Cubic Feet
Niter Consumption in Per Cent
October
November
FIG. 3

FIGS. 1 TO 3

Fig. 1—Weekly operating record for chamber-process sulphuric-acid plant during first year's operation.

Fig. 2—Weekly operating record for same plant during second year.

Fig. 3—Daily operating record for sulphuric-acid plant Oct. 1 to Nov. 25.

year 3.75 tons more of niter was used, manufacturing costs were $0.023 per ton higher (on the same labor rate), and had the yield of acid per pound of sulphur been 4.89, as in the first year, the production of 50 deg. acid the second year would have been 230 tons.

These items would alone amount to considerable, but the greatest saving the first year had over the second was the better use of the chamber space, producing 2,532 tons more of 50 deg. acid than the second year with only the additional cost of 474 tons of sulphur. The graph indicates how advantage was taken of conditions to utilize the chamber space for a greater production.

Fig. 3 is a daily graphic report of operations which may serve as a guide to the acid maker in detecting errors of management and avoiding their repetition by establishing conditions conducive to good running.

In this graph it will be noted that between Oct. 25 and Nov. 7 niter consumption showed the greatest daily variation. Probably in the operator's anxiety for low niter consumption he reduced the supply too much one day and had to "pot" excessively the next. A mean would have been more economical and better results would naturally have been obtained with a consistent, sufficient supply of niter. This condition was evidently found to be the trouble, as a mean seems to have been established and for the following weeks results were uniform.

The daily graphic record would likely call attention to faulty operation of this kind.

Automatic Load Regulator for Motor-Driven Pulp Grinders

By W. H. Artz
Manager Paper Mill Section,
Westinghouse Electric & Manufacturing Co.

IT IS a well-known fact that the load on motor-driven pulp grinders is very fluctuating, unless regulated. The percentage of load variation is greatest where each grinder is driven by an individual motor and usually least where four or more grinders are driven from a single motor, references in these cases being made to the usual type of three- or four-pocket grinders.

Where the magazine type of grinder is used, having only two pockets per stone, the percentage load variation of a single grinder with individual motor is even more severe than in the preceding cases. Even with two magazine grinders driven by a single motor, the load variations, when pockets are put on or taken off, are such as to cause very unsatisfactory operation if an automatic load regulator is not used.

With the best of care and the greatest degree of supervision of the operation of grinders and the filling of the pockets, it is impossible to maintain anything like a uniform load on the grinders. With the class of labor usually employed the load fluctuations generally vary from 25 to 50 per cent above and below the average load, and it is not uncommon to find, where power is being purchased on a peak load basis, that from 25 to 40 per cent more power is being paid for than is actually being used—i.e., power is being paid for on the basis of a peak perhaps 25 to 40 per cent higher than a curve representing the average load. It was largely to correct this condition and to effect other economies that the Westinghouse automatic load regulator for motor-driven pulp grinders was developed. An installation of this regulator is shown in Fig. 1.

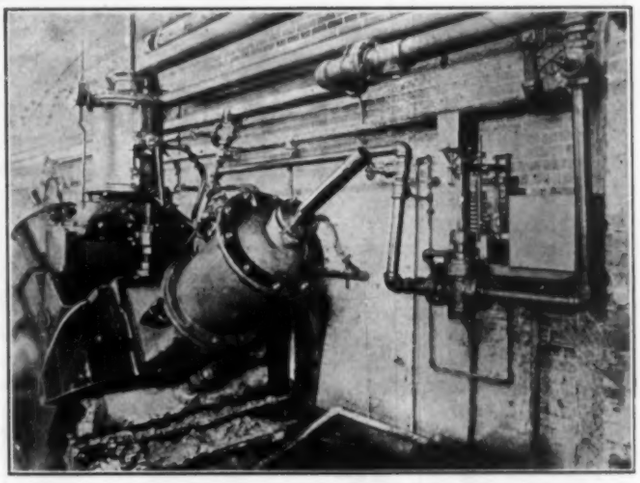


FIG. 1—LOAD REGULATOR ON THREE-POCKET MOTOR-DRIVEN PULP GRINDER AT DEFIANCE PAPER CO., NIAGARA FALLS, N. Y.

With the use of this regulator in connection with each grinder motor, all peaks of any consequence can be prevented, and if ordinary diligence is exercised in keeping the pockets filled, every valley in the load curve, shown in Fig. 2A, can be avoided, thus making practically a uniform straight load curve as the meter chart proves in Fig. 2B, representing constant horsepower input to the grinder motor. This can be accomplished automatically in spite of voltage variations that may take place on the power circuit or change in the power factor setting of the motor itself, and even in spite of the fact that several pockets may be opened at the same time. This precludes all possibility of excess loads and peaks, and assures maximum production and the most efficient and economical use of power.

Description of Apparatus

The Westinghouse automatic load regulator equipment consists of a control panel as illustrated in Fig. 3A, carrying relays, switches and rheostat, the necessary resistance and a motor-operated hydraulic element,

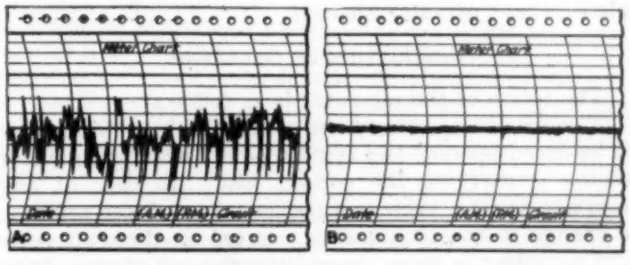


FIG. 2—LOAD CURVE OF PULP GRINDER
A—When not using regulator. *B*—With automatic regulator installed.

shown in Fig. 3B, controlling the water pressure in the pocket cylinders of the grinders being regulated.

The control panel has mounted on it a contact-making watt relay having both current and potential coils; a set of magnetic reversing switches for controlling the direction of rotation of the regulator motor; and a hand rheostat with necessary resistance for determining the load which the grinder motor is to carry.

Two current transformers are used in the grinder motor circuit, the secondaries of the former connecting to the contact-making watt relay. In places where 220-v. alternating current is not available, two small single-phase transformers are provided to furnish poly-

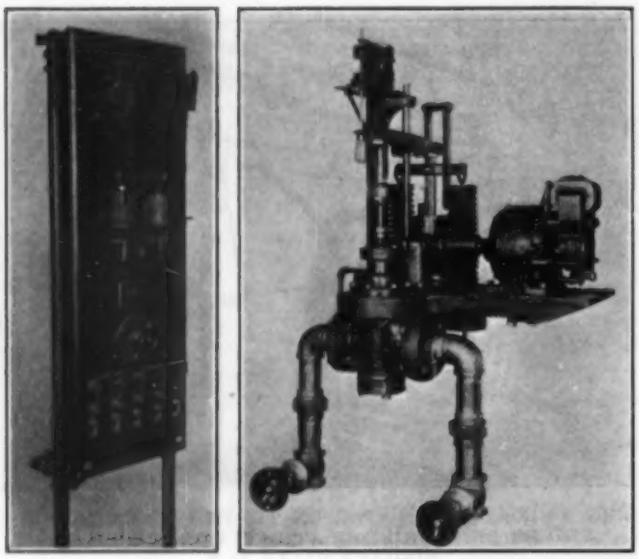


FIG. 3—AUTOMATIC LOAD REGULATOR
A (at left)—Control panel. *B* (at right)—Hydraulic element.

phase current for the regulator motor and for the potential coils of the contact-making watt relay.

The hydraulic element consists of a heavy cylinder type, balanced valve *B* (see Fig. 4) with bleeder element *D*, a small a.c. reversing induction motor *A* with magnetic brake, a moving lever system *L*, a reaction cylinder *M* and a cutout switch *C*. The valve, gears, motor and reaction cylinder are all rigidly mounted in compact form on a common bedplate. The balanced valve *B* controls the hydraulic pressure in the pocket cylinders. Connected directly to the stem of valve *B* is the piston of the bleeder element *D*. The small motor *A* actuated by the watt element raises or lowers the moving lever system *L*, to which is attached the stem of the balanced valve *B*, the piston of the reaction cylinder *M* being attached to the other end of the moving lever *L*. The reaction cylinder *M* is connected to the water-pressure line near the pocket cylinders. The cutout switch *C* limits the travel of the valve and completes the hydraulic element.

Description of Operation

The action of the regulator is as follows:

The sensitive beam of the contact-making watt relay is balanced between two contact points when the grinder motor is carrying the correct load. In case of any decrease in load, such as a pocket taken off for refilling, a change in magnetic pull is exerted on the watt relay and a contact is made, energizing the coil of one of the reversing switches. Thereupon the latter is closed, causing the small motor *A* to rotate in such a direction as to screw upward, through the medium of bevel gears, the vertical rod attached to the lever *L*. The lever *L* fulcrums at the point where it connects with the stem of the reaction cylinder *M*, and the upward movement at the opposite end of the lever increases the opening in the valve *B* and thereby greater water pressure increases the load on the grinder motor to normal or full field. This movement of the small motor *A* takes place very quickly—in fact, in a small fraction of a second—and by it the increase in pressure in the grinding cylinders corrects the load before an appreciable load decrease has occurred.

To prevent hunting, the reaction cylinder *M* is provided. Without the reaction cylinder, the small motor *A* operating through the lever system *L* would open the valve *B* too wide and overload the grinder motor before the watt element would act to stop the small motor *A* or reverse it. The piston in the reaction cylinder *M*, feeling at once the increase in pressure when the valve *B* is being opened, moves upward, which causes the opposite end of the lever *L* connected to the steam of valve *B* to move downward. Counteracting in a measure the movement of motor *A*, as above explained, produces the same effect as stopping the motor *A* before it has overtraveled and permits the lever *L* to assume gradually a position giving a valve opening which keeps the load constant on the grinder motor.

In case of an increase in load, such as a refilled pocket being returned to service, the operations of the regulator are similar to those described above, but in the reverse direction. The watt relay causes the small motor *A* through the lever system *L* to decrease the opening in the valve *B* and reduce the pressure on the pocket cylinders. After the above operation, the tendency is for the stored energy in the hydraulic system to keep the pressure on the pocket cylinders for a considerable time and consequently overload the pulp grinder motor until this pressure is reduced. This condition is overcome by the bleeder valve *D*, which is in the water line between the main valve *B* and the pocket cylinders. When the opening is decreased in the main valve *B*, the bleeder valve *D* opens a greater or lesser

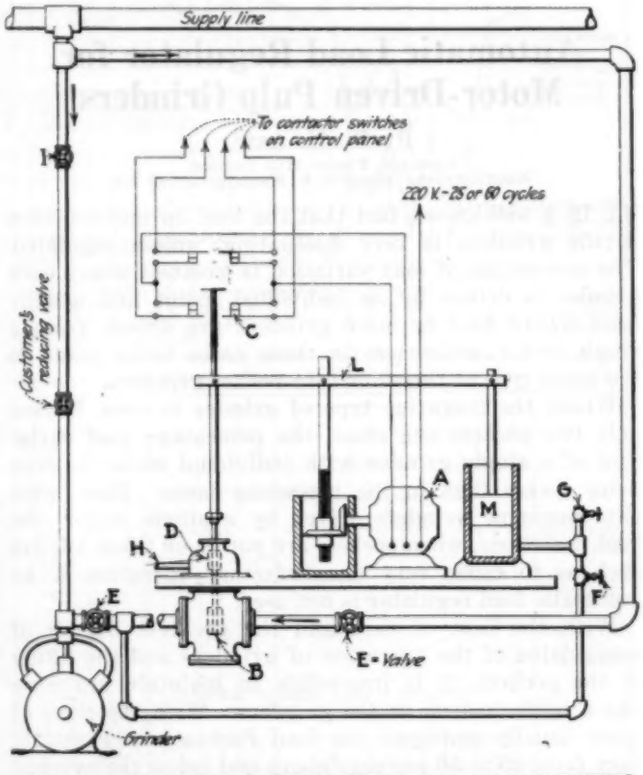


FIG. 4—SCHEMATIC LAYOUT OF HYDRAULIC ELEMENT

degree and relieves the stored pressure at once, thereby eliminating the tendency to overload the grinder motor. Then a further combined action of small motor *A* and the piston in the reaction cylinder *M* restores the valve *B* to the correct position indicated by the load on the grinder motor. A cut-out switch *C* is provided to stop automatically the motor *A* when the travel of the valve *B* has reached its mechanical limit in either direc-

tion—that is, when the valve *B* is wide open or entirely closed.

ADVANTAGES

The possibilities and advantages of the automatic load regulator, proved by actual pulp mill continuous operation, may be summarized as follows:

Constant uniform load can be maintained at all times, preventing all peaks and assuring that no more power will have to be paid for than is actually needed.

There will be no valleys in the load curve and maximum production will be obtained, the load being held at a constant uniform value, even though the operator does not keep the pockets filled as he should.

Greater production can be obtained from the motor and grinding equipment than would be possible under any other conditions, on account of the ability to operate the equipment continuously at maximum capacity, without danger of overloading or exceeding the permissible power demand.

The load on the motor can readily be temporarily reduced by turning the hand rheostat, in cases where the power supply is sometimes limited. Such load setting will be automatically maintained until a further change is made.

The regulator prevents the possibility of overloading the motor, which would trip the circuit breaker, shut down the equipment and interrupt production.

The life of the grinder equipment is prolonged by eliminating, by virtue of constant load conditions, the severe strains and wear and tear to every installation having no regulator.

It being a watt regulator—i.e., regulating for constant load rather than for constant current—constant load is maintained without appreciable variation, regardless of line voltage fluctuations or the power factor of the motor. This is of great value as every change in voltage or power factor would affect the load carried by the motor if the regulator were designed to regulate for constant current instead of constant load.

It being of the relay type rather than of the torque motor type, the valve operating motor has ample power under all conditions to give positive action, regardless of friction or foreign matter in the water.

The anti-hunting means, provided on both the electrical and hydraulic elements, give close regulation to any installation consisting of a motor and any number of grinders. It is worthy of note that good regulation can be obtained with a one-grinder equipment which is impossible with other types of regulators, due to the large load change when one of the pockets is cut out of service for refilling or repairs.

New Chemical Companies Organized

During the month of January, 32 new companies were organized with capital of $50,000 or more, to manufacture chemicals, chemical byproducts, drugs, etc., with aggregate capitalization of $37,650,000. This is a large increase over December, when 26 companies were incorporated, with a capital of $3,595,000, and also a decided advance as compared with January, 1921, which registered indicated capital of new companies of $22,295,000.

In the same month 92 new oil and petroleum companies were formed with individual capital of $50,000 and over, with aggregate capitalization of $100,250,000. This is considerably higher than the record for December, 1921, which showed 58 such new companies organized, with total indicated capital of $65,615,000.

Synopsis of Recent Chemical & Metallurgical Literature

Chromium-Molybdenum Steel.—C. N. Dawe, metallurgical engineer for the Studebaker Corporation, presented a paper on "Chromium-Molybdenum Steel Applications From the Consumer's Viewpoint" before the recent meeting of the Society of Automotive Engineers, in which he presented the results of 400 tests made in the laboratory of a large consumer of alloy steels. Over 2,000 tons of molybdenum steels of various analyses have been put through production in the form of rear-axle shafts, transmission gears and shafts, steering knuckles, steering-knuckle pins, ring gears and drive pinions—in fact, all parts for which alloy steel is specified. By a process of elimination it became clear that an analysis showing a carbon content below 0.30 and above 0.23 per cent, with a chromium content of 0.70 to 0.90 per cent and molybdenum 0.30 to 0.40 per cent, gives satisfactory results with water as a quenching medium, there being no cause for concern pertaining to the development of quenching cracks.

"The wide heat-treating range of a given steel is a property upon which great stress always seems to be laid, but in this present day of accurate metallurgical control we do not need a 100 to 200 deg. quenching range. What we as consumers are mostly interested in is to determine the lowest quenching temperature that can be used commercially and still obtain the maximum physical properties. With this in mind, three quenching temperatures ranging from 1,550 to 1,650 deg. F. were used in the case of the chromium-molydenum, chromium-vanadium and chromium steels, while 1,475 to 1,575 deg. F. were used with the chromium-nickel steel used for comparison purposes. Three drawing temperatures (1,000, 1,100 and 1,200 deg. F.) were used for each quenching temperature."

Physical properties obtained, true to expectations, were occasionally variable in all four types of steel, and his published results are therefore the results of very broad averages.

"Generally speaking, in performing tests of the above nature where we desire to note a comparison of the physical properties of certain steels in terms of the elastic limit, ultimate strength, reduction of area and percentage of elongation, sometimes we are confused because of the variations we obtain, and because it is practically impossible, over a large number of test-pieces, to hold any one or two factors constant so as to note the variation in the remaining factors. If we could heat-treat the test-pieces so that the elastic limit would be the same in all, the variation in the three other remaining factors would tell the story." Failing in this, a comparison by merit index[1] was made, which gave a higher figure for chromium-molybdenum steels than for its competitors. In view of the fact that this steel apparently can be produced in unlimited quantities with no danger of shortage of molybdenum, and because it has been produced and sold at a lower price than its closest competitor, chromium-vanadium steel, its adoption has been sanctioned. It forges entirely satisfactorily, with the particular advantage that the scale formed breaks away from the forgings very easily. With proper composition and for sizes within ordinary limits, it cold-shears as readily as the other grades of commercial alloy steels. It responds very readily to the heat-treating operations, the percentage of forgings falling outside of the required Brinell hardness being very small.

"With reference to its machine qualities, no figures can be given. However, we have satisfied ourselves by noting the machinability of the tonnage that has passed through our shops that chromium-molybdenum steel machines at least as well as the best there is. We have not heard of a

[1] *Merit Index* $= \frac{Elongation\ (Elastic\ Limit + Ultimate\ Strength)}{2{,}000\ (100 - Reduction\ in\ Area)}$

failure of any part made of this steel out of the 50,000 cars that have thus far been produced since its adoption."

Since the Studebaker Corporation is a very large user of carbonized parts, and published literature on molybdenum steels contained little such data, a heat of steel containing 0.13 C, 0.40 Mn, 0.61 Cr and 0.35 Mo was case-hardened. This analysis was abandoned for the reason that too high temperatures were required for double heat-treatment. Quenching directly from the carbonizing box and using a single lower heat for hardening did not produce the desired core fracture. Preliminary work on another analysis (0.19 C, 0.54 Mn, 0.70 Cr and 0.37 Mo) was very encouraging, and transmission parts for 5,000 cars were ordered. It was often noted that a test fracture under shock would not show a "tough core," but would have a crystalline or granular appearance, particularly objectionable in parts that are subjected to a straightening operation and in clash gears. In order to obtain better results, the part to be heat-treated had to be subjected to prolonged heating above the critical temperature of the core to bring about the proper condition before quenching and the lower heat for hardening had to be applied as quickly as possible to prevent the core from being subjected to lengthy heating at the lower temperature.

To obtain the best possible results with the case-hardened parts it was necessary, therefore, to quench from the carbonizing box into oil and follow this by the regular double heat-treatment and a final draw at 375 to 400 deg. F., timing each operation as carefully as possible. There are two particular advantages that should be noted, however, in that chromium-molybdenum steel will take on a given case-depth in 10 per cent less time than chromium-nickel steel; also, there will be a resultant average increase of 5 to 7 points scleroscopic hardness.

"Chromium-nickel steel apparently still holds the first place among commercial steels for case-hardening of important parts, but nickel-molybdenum steel (0.13 C, 0.38 Mn, 1.58 Ni, 0.20 Mo) will be a serious contender, principally because of its ability to harden in oil after carbonizing a rolled (not forged) piece. For instance, steering knuckles have always before been water-hardened, necessitating some rejections due to subsequent straightening. However, of one lot of 1,949 nickel-molybdenum pins carbonized and hardened in oil, not one was lost in straightening or because of softness after final grinding."

The Technical Hydrogenation of Hydrocarbon, Nitrobenzene and Coal.—The *Journal of the Society of Chemical Industry* (vol. 40, No. 23, p. 445R, of Dec. 15, 1921) contained an interesting article on the technical hydrogenation of hydrocarbon, nitrobenzene and coal. It leads to the conclusion that the field of hydrogenation has thus far been but little more than scratched and offers at the same time an engaging prospect for research.

The production of cyclohexane from benzene is not of leading technological importance, although the hydrocarbon has been used in the production of synthetic rubber. Naphthalene when purified has been successfully hydrogenated in Germany to tetrahydronaphthalene, and called "Tetralin" by the Gesellschaft mit beschränkter Haftung of that name at Rodleben, near Rosslau. They produce 120 tons daily. They make also decahydronaphthalene by permitting the absorption of hydrogen to continue further, and a mixture of the tetra and deca products is known on the market as "Tetralin Extra." The deca product, being a fully saturated hydrocarbon, is unattacked by sulphuric or sulphurous acid, and may be likened to paraffin hydrocarbons. The "tetralin," on the other hand, has one benzene nucleus not hydrogenated and suggests many derivatives for use in making dyes and fine chemicals. Besides the war-time use of tetralin as a substitute for turpentine its use is indicated as a motor fuel, as an illuminating oil, as an insecticide, as a solvent for rubber, hydrocarbons, fats, dyes, etherial oils, etc., and as a starting point for dyes.

It is proposed to undertake the hydrogenation of cracked petroleum oils, and thus to avoid important losses. Nitrobenzene is reduced under a Badische patent in which a mixture of CO and steam or water gas and steam react with a copper catalyst to produce aniline. Other methods have been proposed in addition, but an interesting feature of the former is the use of copper as originally proposed by Sabatier in the place of nickel, which would certainly produce cyclohexamine. Copper, on the other hand, is unable to induce hydrogenation of the benzene ring, although it readily acts in the reduction of the nitro group. The Badische process may in time replace the standard method of reducing nitrobenzene with iron borings.

The hydrogenation of alkaloids is another field of peculiar interest, in that it has been observed that in certain cases the toxicity of the original alkaloid is materially diminished by the process.

Of immense interest is the hydrogenation of coal, and here it appears that the Germans have made considerable advance, although they do not seem to have reached any striking success as yet. In the Bergius patent (Br. Pat. 4,574, 1914) it is stated that coal is treated in autoclaves at 400 deg. C. and under high pressure of hydrogen. (Berthollet obtained an artificial petroleum by the action of hydriodic acid on coal in sealed tubes.) Fischer and Schrader, in *Brennstoff Chemie* (1921, vol. 2, p. 161) describe the liquefaction of coal by means of sodium formate. Rhenish lignite yields 7 per cent of tar by destructive distillation, but if mixed with four times its weight of sodium formate the yield is 23 to 27 per cent, and greater if the pressure of gaseous decomposition and steam is kept constant. Thus 45 per cent of tar was obtained from a mixture of one part lignite and two parts sodium formate and 48 per cent from a mixture of one part fuel and eight parts of the salt. The increased production is attributed to the influence of nascent hydrogen from the decomposition of the sodium formate. Molecular hydrogen is said to have very little effect. Fischer and Schrader further say (*Brennstoff Chemie*, 1921, vol. 2, p. 257) that the presence of carbon monoxide at increased temperature such as 500 deg. C. and under pressure gives better yields than hydrogen as in the Bergius process, but that it is less successful than when sodium formate is employed.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Production of Ferrozirconium.—Ralph H. McKee, of New York City, patents a method for making ferrozirconium, substantially free of Al, not more than 3 per cent Si and containing 20 to 40 per cent Zr, and 0.5 per cent C, by fusing a mixture of 500 parts granular zircon with 300 parts cast iron, 250 parts CaO and 25 parts fluorspar in a resistance furnace. (1,401,265. Dec. 27, 1921.)

Zirconium Steel.—Ralph H. McKee, of New York City, claims to be able to make zirconium steels by merely adding zirconium oxide or silicate minerals to the molten iron or steel, without fluxes or other reagents. About one-quarter of the metal in the added mineral is reduced and enters the alloy; in this way irons containing as high as 20 per cent Zr may be made. (1,401,266 and 1,401,267. Dec. 27, 1921.)

Heat-Treatment of Aluminum Alloys.—Earl Blough, of Parnasus, Pa., finds that a great variety of Al:Cu alloys may have their tensile strength greatly increased by a proper double heat-treatment, combining a thorough anneal at about 520 deg. C. and a quench in boiling water, in which it is permitted to remain for several hours. The high temperature should be maintained for a sufficient time to relieve strains, allow recrystallization and uniform diffusion of soluble constituents. Accelerated aging of the quenched specimen is effected by the bath of boiling water. (1,394,534; assigned to Aluminum Co. of America. Oct. 25, 1921.)

Recovery of Chromium From Iron Ore.—F. A. Eustis of Milton, Mass., proposes to leach finely divided soft Cuban iron ores with weak HCl with or without H_2SO_4, extracting

therefrom Fe, Al, Ni and Mn, and leaving behind SiO_2 and the chromium minerals in such enriched form that the latter can be easily recovered by smelting, (1,403,237; partially assigned to C. P. Perin. Jan. 10, 1922.).

Molybdenum From Molybenite.—G. W. Sargent and J. W. Weitzenkorn, of Washington, Pa., have discovered an exothermic reaction between molybdenite and manganese oxide:

$$MoS_2 + 2MnO_2 + 4C = Mo + 2MnS + 4CO$$

The powdered reagents (with or without iron filings) are mixed, heated to 2,000 deg. F., whereupon a button of substantially pure Mo (or ferromolybdenum) forms, containing less than 0.10 per cent sulphur, overlain by a clean, fluid slag. If carbon is not added to the mix, the end product is a reducible Mn:Mo:S compound. Or the complete reaction may be effected during steel-making operations, with the resultant formation of excellent alloy steel. (1,401,924. Dec. 27, 1921.)

Primary Detonating Compound.—This invention refers to the use of diazodinitrophenol (4.6-dinitro-2-diazophenol) as a substitute for the fulminates, azides, etc., used in primary detonating charges. Non-metallic primers have met with little use for reasons of high cost, low brisance, unfavorable temperatures of melting and ignition and undependable sensitiveness to shock. It is claimed that diazodinitrophenol is free from these objections and can be used for general primary detonating charges and for special charges designed to avoid fouling and amalgamating the metals of ordnance. It is not hygroscopic and is stable in the presence of acids, hence is not decomposed by decomposition products of explosives during storage. When mixed with potassuim chlorate it is claimed to reveal greater power than the most efficient mixtures of potassium chlorate and mercury fulminate. (1,404,687. W. H. Dehn, Seattle. Jan. 24, 1922.)

Book Reviews

A LIFE OF GEORGE WESTINGHOUSE. By *Henry G. Prout, C.E., A.M., LL.D.* New York: Charles Scribner's Sons. 1922. Price, $2.50.

This is an interesting book about a remarkable man who was one of the great American inventors. The name Westinghouse, now known all over the world, appears to have been originally Wistinghausen until on the immigration of the pioneer to New Hampshire in 1755, when it was changed to the present style. Genealogy is seldom illuminating, because many of the factors are illusive, but the Westinghouse strain seems to have held true to form. There was the original John of 1755 who came over with his widowed mother when he was fifteen years old. On the ship he made for his mother an inlaid wooden work-box which is still in existence. John cleared the land, built a log cabin and raised a large family. That inlaid work-box indicates a mechanical knack. John was 6 ft. 4 in. tall. One of his sons was John Ferdinand, who had twelve children, the fifth of whom was George, Sr. He settled in Central Bridge, N. Y., married Emmeline Vedder, a cousin of the famous artist, Elihu Vedder, whose illustrations of the Rubaiyat of Omar Khayyam will be familiar to most of our readers. They had ten children, of whom George, Jr., was the eighth. George, Jr., was born in 1846. Ten years later George, Sr., established himself at Schenectady as G. Westinghouse & Co., makers of agricultural and mill machinery and small steam engines, on the site of the entrance to the General Electric Co.'s present great works.

There were three sons of the Schenectady master mechanic who served in the civil war: John, Albert and George, Jr. The tradition is that Albert, who was singularly gifted in mind and character, was the most promising of all the sons. He was killed while leading a cavalry charge in 1864. John served as an engineer officer in the navy and then returned to his father's business in Schenectady. There he established a night school and a mission, and he gave all his available time to helping the unfortunate. He died when George was forty-four years old.

If we were considering a baseball hero or a race horse we should be very diligent in noting qualities of inheritance, but we are less addicted to this in considering men who achieve greatness. We present the data, together with a reminder of his younger brother, Henry Herman Westinghouse, of Pittsburgh, and the fact that a considerable number of the Wistinghausen family in Westphalia have received patents of nobility, to indicate the strong rather than a weak biological strain that was the inheritance of George Westinghouse, Jr.

When George returned from the war, having enlisted at sixteen and been mustered out under nineteen, he entered Union College as a sophomore, but 3 months later he returned to the shop. The old "Hands Book" of the shop also shows that back in 1860 when he was thirteen and one-half years old he worked there for 50 cents a day, and that in 1863 he was getting $1.12½ a day. It appears therefore that after George was thirteen years old he had but 1½ years of school and college. Nevertheless he wrote and spoke English uncommonly well.

His first patent invention was a rotary steam engine, recorded in 1865. The foundation of his fame and fortune was the air brake, on which his first patent was granted in 1869. By 1873, when he had moved to Pittsburgh, he had taken out twenty or more patents on details of brake apparatus. Then followed at various times friction draft gear and the immense electric activities in which Westinghouse had the vision and the energy to press the development and application of alternating currents. This was a herculean task that we can only mention. In like manner we can only mention the development of the induction motor and meter, the rotary converter, turbo-generators, signaling and interlocking, and a vast number of other activitities.

His most outstanding quality today is the fact that while he was not scientifically trained (and all his life he felt his defect in higher mathematics and physics) he had the scientific spirit. He gathered men of sound scientific training about him and worked with them. He was on terms of intimate friendship with the leading scientific minds of the world. Unlike some chemical manufacturers of today, he respected science, revered it, had it in his blood, recognized its intricacies and did not suffer from the illusion that he could carry it on his pocket-book.

He blazed the trail for the introduction of science into industry. It would be gratuitous to say that he was alone in this, but the number of these pioneers is small. Look at the number of great engineers of today who have been through the course as graduates with the Westinghouse Co. and the General Electric Co.! Can the chemical industry of this country point to such a number of able, courageous and commanding men as the electrical industry has turned out? Everybody knows it cannot. And everybody ought to know why.

He was an idealist all the time and an optimist when others were lost in darkness. The panic of 1907 swamped him, and receivers were appointed for the Electric company. It would be difficult to make a correct analysis of the causes of this. Whether the single-phase electrification of the New Haven Railroad had much to do with it or not would probably be debated. Many lenders ask high discounts when money is scarce, and he may have held off too long. He made many mistakes among his efforts, and without doubt he made them in his financial planning. But when the crash came, he put what he had back in the works and so did his employees. And while he died in moderate circumstances, the works continue to do what he planned for them to do, and the name leads on, unsullied by failure.

ELLWOOD HENDRICK.

* * *

CHEMICAL REACTIONS AND THEIR EQUATIONS. A Guide and Reference Book for Students of Chemistry. By *I. W. D. Hackh*, professor of biochemistry, College of Physicians and Surgeons of San Francisco. Philadelphia: P. Blakison's Son & Co. Price, $1.75.

This convenient and helpful book was reviewed in our issue of Dec. 7, 1921. In that review the price was stated to be $1.25 and some readers have sent in orders with only that amount inclosed. The correct price, as stated above, is $1.75.

Outlining the Legitimate Activities of Trade Associations

ONE of the disturbing factors in the present business situation has been the uncertainty regarding the definition and scope of the activities of legitimate trade associations. Ever since the Supreme Court's decision in the case of the Hardwood Manufacturers' Association, business has anxiously awaited the anouncement of the government's attitude toward trade associations. It had been hoped that through the services of Secretary of Commerce Hoover, the Attorney-General might be induced to prepare a formal statement in the nature of an interpretation of the Supreme Court's decision. Following a number of conferences between officials of the Justice and Commerce Departments it was finally decided, however, that the government's statement should take the shape of "an informal interdepartmental inquiry regarding the present status of the law relating to legitimate trade associations and the extent that they may engage in legitimate co-operative activities."

The Hoover Inquiries

In the interdepartmental correspondence, which has recently been made public, Secretary Hoover has outlined a vigorous defense of the legitimate trade association as an essential service to industry. He made the following statement in the first of his letters to the Attorney-General:

> It is with much earnestness that I claim there is propriety, generally speaking, in trade associations. Their lawful field of endeavor is large, and their activities work for promotion and advancement of the public welfare and for progressive economic organization. In making this statement, I am not unmindful of the fact that the impression exists with a small minority that individual prohibited acts may be accomplished by organization under the disguise of a trade association. However, to make my position clear regarding the trade associations the existence of which I advocate, I desire to say that I have always taken the view that no body of men could combine in the form of a trade organization and do any act or thing forbidden by law if they were undertaken by them outside of a trade organization. The character of trade organization the existence of which should be preserved is one that carries only lawful purposes in its articles of association; its activities must be in harmony with its declared purposes. The articles of association, with their lawful, declared purposes, must not be used as a mask to hide unlawful purposes. In other words, the organization cannot be used to conceal or disguise any contract, combination, conspiracy, agreement or understanding, secret or otherwise, on the part of the officers of the organization or on the part of the membership or any part thereof to engage in activities in restraint of trade or otherwise in violation of the anti-trust laws.

The Attorney-General was asked by Secretary Hoover for an informal expression of his views as to the following activities of trade associations and their members, it being assumed, of course, that neither the form of the association nor the activity which appears perfectly fair and lawful on the surface is used to hide or conceal some contract, combination, conspiracy, agreement or understanding, secret or otherwise, on the part of the association, the membership or any part thereof actually to restrain trade or otherwise violate the Sherman act:

Uniform Costs and Industrial Standardization

(1) May a trade association provide for its members a standard or uniform system of cost accounting and recommend its use, provided that the costs so arrived at by the uniform method are not furnished by the members to each other or by the members to the association and by the latter to the individual members?

(2) May a trade association advocate and provide for uniformity in the use of trade phrases and trade names by its respective members for the purpose of ending confusion in trade expressions and for harmony of construction as to the meaning of trade phrases, names and terms?

(3) May a trade association, in co-operation with its members, advocate and provide for the standardization of quality and grades of product of such members, to the end that the buying public may know what it is to receive when a particular grade or quality is specified; and may such association, after standardizing quality and grade, provide standard form of contract for the purpose of correctly designating the standards of quality and grades of product; and may it standardize technical and scientific terms, its processes in production and its machinery; and may the association co-operate with its members in determining means for the elimination of waste processes in production and distribution and for the raising of ethical standards in trade for the prevention of dishonest practices?

Credit, Insurance and Co-operative Advertising

(4) May a trade association collect credit information as to the financial responsibility, business reputation and standing of those using the products of the industry; and may the association furnish such information to individual members upon request therefor, provided such information is not used by the association or the members for the purpose of unlawfully establishing so-called "blacklists"?

(5) May a trade association arrange for the handling of the insurance of its members, including fire, industrial, indemnity or group insurance? In other words, can the members of an industry, through the agency of a trade association, arrange for or place all of the insurance of the members?

(6) May a trade association, in co-operation with its members, engage in co-operative advertising for the promotion of trade of the members of that association engaged in the particular industry; and may the association engage in such form of promotion by furnishing trade labels, designs and trade marks for the use of its individual members?

Industrial Relations, Legislation and Governmental Co-operation

(7) May a trade association, for and in behalf of its members, engage in the promotion of welfare work in the plants or organizations of its members, which welfare work includes sick benefits and unemployment insurance for employees, uniform arrangements for apprenticeship in trade education, the prevention of accident and the establishment of an employment department or bureau for co-operation with employees?

(8) May a trade association, in co-operation with its members and acting for and in behalf of its members, handle all legislative questions that may affect the particular industry, regarding factories, trades, tariff, taxes, transportation, employers' liability and workmen's compensation, as well as the handling of rate litigation and railroad transportation questions?

(9) May a trade association, in co-operation with its members and acting for and in their behalf, undertake the promotion of closer relations between the particular industry and the federal and the state departments of government which may have administration of laws affecting the particular industry in any form?

Statistics of Production, Distribution and Prices

(10) *A.* May a trade association collect statistics from each member showing his volume of production, his capacity to produce, the wages paid, the consumption of his product in domestic or foreign trade, and his distribution thereof, specifying the volume of distribution by districts, together with his stock, wholesale or retail?

B. And may such trade association, on receipt of the individual reports of each member, compile the information in each report into a consolidated statement which shows the total volume of production of the membership, its capacity to produce by districts of production, which, in some instances, include a state or less area, the wages by districts of production, the consumption in foreign or domestic trade by districts, the volume of distribution by districts and the stocks on hand, wholesale and retail, by districts?

C. And if, after compiling the information as aforesaid, the information received from the members as well as the combined information is not given by the association to any other person, may it then file the combined statement with the Secretary of Commerce for distribution by him to the

members of the association through the public press or otherwise and to the public generally and to all persons who may be in any way interested in the product of the industry, it being understood that the individual reports for the members should cover either weekly, monthly, quarterly or longer periods as may be deemed desirable by the members, and, when a period is adopted, the report for each member shall cover that period, and the combined report shall be for that period?

(11) *A.* May a trade association, at the time it collects the production and distribution statistics above outlined, at the same time have its members report the prices they have received for the products they have sold during the period taken, specifying the volume of each grade, brand, size, style or quality, as the case may be, and the price received for the volume so sold in each of the respective districts where the product is sold?

B. And may the association, without making known to any person the individual price reports of any member, consolidate all of the reports into one, and show the average price received for the total volume of each grade, brand, size, style or quality, as the case may be, distributed in each district covered by the distribution statistics for the period covered by each individual report?

C. And may the association, after making such compilation, send the compiled report as to average price, as aforesaid, to the Secretary of Commerce, to be by him distributed to the public and to any or all persons who may be interested in the particular industry making the reports?

The Attorney-General's Reply

Mr. Daugherty's answers to these questions are contained in his letter to the Secretary of Commerce dated Feb. 8, 1922. The Attorney-General laid particular stress on the subjects of uniform cost accounting and standard trade marking and labeling especially when used as a means of restraining trade and competition. His statement is, in part, as follows:

Suspicious of Uniform Costs

With reference to the first paragraph, there is no apparent objection to a standard system of cost accounting, but I think associations should be warned to guard against uniform cost as to any item of expense. For illustration, a strong effort has been made by some lumber associations to take as a basis for estimating costs of production a uniform charge for stumpage. Of course the cost of the timber in the tree to the different manufacturers who own their timber in the woods varies greatly; and as to each it should be charged at its actual cost. It is as clearly a violation of the law to agree upon the cost of an item that constitutes a substantial part of the total cost price, when its cost actually varies, as to agree upon the sales price, because the sales price is substantially affected by such agreement. It has been ascertained that the members of one association go so far as to fix a uniform cost price, leaving to each member to determine what per cent profit he will add, thus eliminating competition entirely in so far as affected by the cost of production.

Uniform Labels Destroy Competition

Furthermore, I have serious doubts about the advisability of the latter part of the sixth paragraph. I can see no objection to co-operative advertising designed to extend the markets of the particular article produced or handled by the members of an association, but when the several producers or dealers use uniform trade labels, designs and trade marks it seems to me the inevitable result would be a uniformity of price. Where two competing articles are advertised in precisely the same way and bear exactly the same label or trade mark, it certainly would be difficult for one to be sold at a higher price than the other, although its quality may be superior. In a way this is illustrated in the cement industry. There a standard of quality has been adopted—that is, it is necessary for all cement to comply with a certain standard—but in practice no manufacturer undertakes to make, or at least no one advertises that he does make, a grade of cement superior to that standard. The result is that there is no competition in the sale of cement so far as quality is concerned. It seems to me therefore that it would be well to eliminate the latter clause in paragraph 6—to wit, "and may the association engage in such form of promotion by furnishing trade labels, designs and trade marks for the use of its individual members?"

I can now see nothing illegal in the exercise of the other activities mentioned, *provided always* that whatever is done is not used as a scheme or device to curtail production or enhance prices, and does not have the effect of suppressing competition. It is impossible to determine in advance just just what the effect of a plan put into actual operation may be This is especially true with reference to trade associations whose members are vitally interested in advancing or, as they term it, stabilizing prices, and who through the medium of the associations are brought into personal contact with each other. Therefore the expression of the view that the things enumerated by you, with the exceptions stated, may be done lawfully is only tentative; and if in the actual practice of any of them it shall develop that competition is suppressed or prices are materially enhanced, this department must treat such a practice as it treats any other one which is violative of the anti-trust act.

Community Trade Slogans and Not Trade Marks

Mr. Hoover in a second communication offers a further explanation of paragraph 6, which had been questioned by the Attorney-General. It was intended that the question should really relate to trade promotion through the use of trade slogans, such as "Made in Grand Rapids," and not to the use of the same trademark by every member of an association. Since this is primarily the sort of co-operative advertising to which Mr. Daugherty referred—i. e., "designed to extend the markets of the particular article produced or handled by the members of an association," it is apparent that the views of the two departments are in complete accord.

A List of Trade Association Activities

The fabricated production department of the U. S. Chamber of Commerce has prepared a tentative list of trade association activities which is based upon returns received from many association secretaries. It will be noted that in addition to those discussed in the Hoover-Daugherty correspondence there are numerous activities which have had the attention of the various trade associations. The listing by the Chamber of Commerce is not, however, an indication of the legal character of the different activities and no effort has been made to comment on their relative importance to business. The list of seventy-eight trade association activities is as follows:

Adjustments.
Advertising.
Arbitration.
"Association Spirit" and "Acquaintanceship."
Bulletins.
Classifications.
Collections.
Compensation.
Compilation of Trade Information.
Conservation.
Co-operation.
Co-operative Advertising.
Co-operative Buying.
Co-operative Selling.
Co-operation With Other Trade Organizations.
Cost Accounting and Cost Finding.
Credit Bureau.
Demonstrations.
"Distribution and New Markets."
Educational.
Eliminations of Excess Variety.
Elimination of Abuses (Trade Practices).
Employment Bureau.
Ethics of Business.
Exchange of Surplus Materials.
Exhibits.
Financial Statement Consolidated, Yearly.
Foreign Trade Service.
Freight Classification.
Group Meetings.
Hand Books.
House Organs.
Industrial Bureau.
Inspection Service.
Insurance.
Investigations. Technical (Testing, etc.).
Labor Problem.
Legal Advice.
Legal Aid.
Legislative Work.
Litigation.
Market Reports.
Materials, Raw.
Methods.
Open Price Bureau.
Open Shop.
Organization.
Patents and Trade Marks.
Price Data Exchange.
Production.
Publicity, General.
Purchasing.
Price Lists and Classified Buyers' Guides.
Relation Between Own Industry and Allied Industries.
Research.
Restriction of Production.
Sales Promotion.
Social Contact of Competitors.
Standardization.
Statistics (1. Production, 2. Shipments, 3. Orders).
Statistics, Production.
Statistics, Wage Rates, Volume of Orders on Hand, Cost of Manufacture, Overhead Expense.
Style Bureau.
Tariff Work.
Taxation.
Technical Education.
Technical Information.
Trade Extension Work.
Trade Information.
Trade Marks and Copyrights.
Trade Practices (Co-ordination).
Trade Promotion (or Stimulation).
Traffic Department.
"Unfair Competition Bureau."
Wage Rates Compilation.
Wage Schedules, Detailed.
Washington Representation.
Welfare.

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Chemical Research for Army and Navy Threatened by Abolition of Gas

If the treaty among the United States, Great Britain, France, Italy and Japan dealing with the use of submarines and gases in warfare is ratified, there is reason to believe that an attempt will be made not only to abolish the Chemical Warfare Service as such but to stop practically all of the research work being done on war gases. A good deal of money is being expended at Edgewood Arsenal and in view of the way expenses are being lopped off, it is regarded in Washington as highly probable that executives will not overlook this chance to reduce expenditures.

The Chemical Warfare Service brought to the military and naval establishments the first chemical research of any proportion ever undertaken in these large and important government departments. Every effort has been made at Edgewood Arsenal to be helpful to all branches of the Army and the Navy when a matter of chemistry was involved. Unless a very determined protest is made, the chances favor the wiping out of this service.

It will be recalled that Congress has been more alive to the chemical warfare situation than have the General Staff or secretaries of war. Due to the fact that Congress now has under consideration the War Department appropriation bill, it will have an opportunity to present its own interpretation of the gas treaty. Hearings on this bill are now in progress before the Appropriations Committee of the House. Every effort will be made to convince the committee that gas research should continue as a necessary measure toward national defense with which can be combined such other chemical research as is required by the Army and Navy.

E. F. Smith to Deliver Chandler Foundation Lecture at Columbia University

Friends of Professor Chandler presented in 1910 to the trustees of Columbia University a sum of money which constitutes the Charles Frederick Chandler Foundation. The income from this fund is used to provide a lecture by an eminent chemist and to purchase a medal to be presented to the lecturer in further recognition of his achievements in science. Previous lecturers on this foundation were L. H. Baekeland, Sc.D., W. F. Hillebrand, Ph.D., W. R. Whitney, Ph.D., and F. Gowland Hopkins, Ph.D.

The lecturer this year will be Edgar Fahs Smith, formerly professor of chemistry at the University of Pennsylvania, now president of the American Chemical Society. Dr. Smith's subject will be "Samuel Latham Mitchill—A Father in American Chemistry." Samuel Latham Mitchill was the first professor of chemistry at Columbia College and the first Senator from the State of New York. The lecture will be in Havemeyer Hall, Columbia University, on March 2, 1922, at 8:15 p.m.

Revised Patent Office Relief Bill Passes Senate Without Opposition

Not even the most optimistic friend of the Patent Office relief bill expected that measure to go through the Senate without considerable debate. The greatest surprise of all was that no roll call was demanded. Senator Johnson simply pointed out that the Senate is entirely familiar with this measure, which had been passed at the last session but which failed due to differences in conference over a proposal to handle government employee patents on a preferred basis, which is not a part of the present measure.

The bill provides for an increased salary schedule for technical employees in the Patent Office and authorizes the reorganization of that important bureau.

Discussion Aroused by Superpower Report Paves Way for Further Action

Now that ample time has been given to obtain the reactions of the electrical industry to the superpower report, the members of the advisory board are to be called together in the near future for further discussion of the project.

Dr. George Otis Smith, director of the U. S. Geological Survey, under whose direction the superpower report was prepared, believes that the showing of economies presented in the report has stimulated interconnection between existing systems throughout the country. The nationwide interest that has been taken in the report is indicated by the fact that the entire edition of 10,000 copies of the report has been exhausted. Thousands of inquiries have been received in regard to various phases of the problems involved and a large amount of discussion has been incited in technical societies and the technical press.

Secretary of Commerce Hoover states that the superpower report has stimulated the desire for similar studies in the Pittsburgh-Chicago area and in other sections.

Appointment of A. B. Houghton as Ambassador to Germany Confirmed

The choice of a manufacturer as Ambassador to Germany is of general interest to American industry and in this case, of particular interest to the chemical industry. In selecting Alanson B. Houghton for that post, the President has picked a practical man who is thoroughly familiar with the chemical industries and who has made research one of the important features of his great glass-making enterprise at Corning, N. Y. The laboratory that he maintains in connection with his glass works is said to be the most complete of its kind in the world.

Mr. Houghton was born in Cambridge, Mass., in 1863. His preliminary education was obtained at St. Paul's School at Concord. He specialized in economics at Harvard and was graduated from that institution in 1886. Shortly after his graduation he continued his study of economics in Europe. Three years of that time were spent in Germany. On his return to the United States he entered the glass works in one of the most humble capacities and learned the business in the plant of which he finally became the head. In 1918 he was elected to Congress. For 2 years he served on the Foreign Affairs Committee, after which he was chosen for membership on the Ways and Means Committee. He took an active part in the framing of the Fordney tariff bill. His intimate knowledge of the industrial situation in Germany made it possible for him to interpret to the committee many phases of the German situation which had a bearing on tariff making.

New Jersey Chemical Society Hears Prof. Hill and R. H. McCready

An interesting discussion of some of the peculiar properties of silver perchlorate was presented before the New Jersey Chemical Society in Newark, N. J., Feb. 13, by Arthur E. Hill, professor of physical chemistry at New York University. Besides a description of this and other little-known salts related to it, the speaker pointed out some of the possible practical applications of these properties. He suggested the possibility of using the salt in the determination of water in gasoline and for the quantitative estimation of aniline.

Robert H. McCready, publisher of *Chemical Age*, New York, described some of the features of his recent trip to Germany, emphasizing the apparently prosperous condition of the population.

Interest in Power Company's Offer Overshadows Ford Proposal

With the submission of a bid for Muscle Shoals by the Alabama Power Co., the discussion of the project has taken on a new interest. The hearings in progress before the House Committee on Military Affairs had excited very great interest since their inception on Feb. 9. Apparently, nine members of the committee have not been convinced that the Ford proposition should be accepted. Seven members are avowedly for the acceptance of the offer, while the five remaining members can be classed as doubtful.

From a chemical standpoint, most interest centers around the testimony of Richard C. Tolman, director of the Fixed Nitrogen Research Laboratory of the Department of Agriculture. Dr. Tolman made a clear and complete statement concerning the kinds of material that can now be manufactured at the nitrate plant and the possible future development of other materials such as fertilizer, urea and nitroguanidine. He described the changes that would be necessary in the plant to produce these different products and expressed the opinion of the laboratory that the plant could not be made to pay expenses if run to produce ammonium sulphate at its present market price.

Offer by Alabama Power Co.

The Alabama Power Co., Birmingham, Ala., has submitted an offer to the secretary of war which seems to offer advantages not presented in previous offers. The company proposes to take out a license under the federal water-power act under which it will complete the construction of Wilson dam and power house at its own expense. The company offers to furnish free to the government or anyone it may designate, from the hydro power plant, 100,000 hp. as required for the production of fertilizers and munitions of war.

It is proposed that the company purchase the government's interest in the Warrior extension of the steam plant, substations, transmission line and the steam plant at Nitrate Plant No. 2, with the necessary rights of way, and to pay therefor the sum of $5,000,000, less an amount to be agreed upon to cover the cost of the locks and navigation structures at Wilson dam. Under the terms of the proposal, the government is to transfer to the licensee the Wilson dam property represented by its investment and commitments to date, free of liabilities and unencumbered. The locks and navigation structures would be conveyed to the government in fee on completion of construction. In accordance with the water-power law, the project covered by the license would be subject to recapture by the government at the end of 50 years and would be turned over to the government for the production of munitions at any time as may be judged necessary by the President.

House Considering Several Proposals Regarding Project

Senator Norris of Nebraska, chairman of the Senate Agriculture Committee, which will consider the Muscle Shoals lease project, proposes that the committee shall visit Muscle Shoals to take evidence and make a personal investigation as to the advisability of completion of the government improvement either by the government or by lease. He has introduced a resolution authorizing this investigation, which has been referred to the committee controlling Senate expenses.

Representative Jones of Texas has introduced in the House a bill to accept the Ford proposal to lease the plant.

The Association of Practical Inventors of New York has petitioned Congress asking that the War Department retain the nitrate plant for the establishment of national instruction, training, experimenting and testing bureau for explosive chemicals, instructors, testers, etc., in preparing chemicals used for explosive chemical purposes.

General Williams Before Military Affairs Committee

While no new points of great significance have been brought out during the Muscle Shoals hearing before the Military Affairs Committee of the House, the testimony has had the effect of concentrating attention on the more important phases of an intricate negotiation.

General C. C. Williams, Chief of Ordnance, emphasized that the Ordnance Department feels a very vital interest in fixation of nitrogen, and that it must use every endeavor to see it brought about. The guarantee embodied in the Ford offer to keep the plant in operation during the term of the lease was held by General Williams to be of greatest importance. To pay $11,000,000 for nitrogen preparedness is a very moderate sum, he said.

Will Not Reduce Fertilizer Cost

When Representative Parker of New Jersey stated that he was not impressed with the arguments to the effect that fertilizer could be made cheaper by the operation of these plants, General Williams stated that his estimates on the cost of ammonium sulphate produced at Muscle Shoals does not lead him to believe that the cost of fertilizer can be cheapened materially. He pointed out, however, that the fixation of nitrogen is in its infancy. In that connection he said: "Fixation of nitrogen is being studied constantly in all of the scientific countries. It is something all recognize as essential. The supplies in Chile are being exhausted and it probably will not be a great many years before that country no longer will be able to supply the needs of the world. Just which will be the successful synthetic method no one can say. Those who have studied the question differ as to the best process. They all agree that in the not far distant future the fixation of nitrogen will be on a commercial basis, just as the production of pig iron."

General Beach Favors Ford Offer

General Lansing H. Beach, Chief of Engineers of the Army, told the committee that one of the great difficulties in handling the Muscle Shoals proposition was the fact that no definite assurance could be given prospective bidders. He said Mr. Ford is the only one who would make a definite response under those conditions.

With regard to the 50-year limit on water-power leases, General Beach said it is not always advisable to apply a general rule. In the case of Muscle Shoals there are arguments for an exception. The territory tributary to Muscle Shoals, he pointed out, is not yet a thickly settled portion of the country. Manufacturing is not highly developed and the length of time that would be required to develop a market for the power must receive careful consideration. He said that it had taken 20 years to utilize all of the power at Niagara Falls in spite of the fact that it is in the heart of a great industrial section. Continuing, General Beach said: "I understand that Mr. Ford intends to utilize this secondary power in a way that we would have considerable difficulty in developing a customer. I believe he proposes to install electric furnaces. They would be used whenever the power is available and he could utilize the secondary power in that way to great advantage and do it immediately."

Secretary Weeks Repeats Former Views

The testimony of Secretary of War Weeks before the committee was practically a reiteration of points made in his statement in transmitting the offer to Congress, published in Chemical & Metallurgical Engineering for Feb. 8. 1922.

"I believe there will be in 20 years a large number of plants in the United States producing nitrates," he said. "It is going to be a very common process. Within a limited number of years there will be a great amount of nitrogen recovered from the atmosphere, so that the question of the government maintaining a plant for this purpose may not be vital.

"The whole essence of Mr. Ford's offer, in my judgment, is whether people are going to get fertilizer at lower cost than heretofore. If that phase of the offer were eliminated, I think quite as advantageous disposition could be made of this property."

Interior Department Research Appropriation

The Interior Department appropriation bill as reported to the House provides $40,000 for chemical and physical researches by the Geological Survey, which is the same appropriation as for the current year.

International Conference on Water Pollution by Vessels at Sea Proposed

Hearings were held Feb. 15 by the House Foreign Affairs Committee on a resolution of Representative Appleby to call an international conference to amend the maritime laws to prevent discharge of oil by vessels at sea, which is said to contaminate shore waters. This is a companion measure of the Appleby bill to regulate discharge of oil, chemicals, etc., in American waters. Government officials were heard by the committee, including legal authorities of the Departments of State and Commerce.

A.C.S. Plans Trip to Southern Plants as Preliminary to Convention

The Washington Section of the American Chemical Society is arranging for a special train to leave Washington Friday evening, March 31, to enable members to visit Kingsport, Tenn., and the Clinchfield region, Chattanooga, Tenn., and Muscle Shoals, Ala., and arrive in Birmingham, Ala., on April 3 for the annual convention of the society. Detailed plans have not yet been made for the entertainment at Kingsport, Tenn., and at Muscle Shoals.

Saturday will be spent either at Knoxville or at Chattanooga, probably at the latter city. The region around Kingsport, Tenn., has become an interesting industrial center and large plants, such as the Clinchfield Portland Cement plant, the extract plant and tannery of the Grant Leather Corporation, a large facebrick plant and the wood-distillation plant of the Tennessee Eastman Corporation, are in operation. An immense leather-working plant of the Simmons Hardware Co. and the new plant of the Corning Glass Co. are ready for operation, but are at present closed down. The Union Dye & Chemical plant has ceased operations. The plants which are in operation, however, are sufficient to give a very interesting day for members and it may be possible to extend the trip to South Clinchfield to view the Carbocoal process of the International Coal Products Co., which is the only going concern making use of processes of low-temperature distillation of coal combined with the production of briquetted solid fuel. The possibility of visiting this plant appears to be entirely a question of time. If visited, there will be a slight addition to the railroad fare. At Chattanooga there are important industrial plants, such as byproduct coke plants, electric furnace manufacture of ferro-alloys, cottonseed and peanut oil refining, hydrogenation of oils, alum plant, etc.

Permission has been obtained to visit the nitrate plant and water-power development at Muscle Shoals. This permission is limited to American citizens and to those who have no personal connection with or financial interest in the manufacture of cyanamide. Ladies and personal guests may accompany members.

The train is contingent upon 125 guaranteed fares. Early application should be made to secure accommodations desired. Tickets should be bought from point of departure, via Washington over the Southern and Norfolk & Western railroads, direct to Birmingham. If 350 people purchasing tickets by certificate plan are present in Birmingham at the meeting, a return ticket via same route may be purchased at one-half the regular fare. Extra tickets for side trips and for Pullman accommodations must be purchased in advance and check for same, made out to Charles L. Parsons, chairman of the committee, must accompany application. No application for space will be considered unless accompanied by remittance.

Extra railroad charges for side trips Johnson City to Kingsport and return and Chattanooga to Muscle Shoals will be $10.87. The Pullman fares for all four days will be $13.20 for upper berth, $16.50 for lower and $58 for drawing rooms. These charges for Pullman are made to cover necessary guarantees. If Pullman cars are filled, there will be rebate of any excess fare paid. Application for space must be made on or before March 20. If 125 applications accompanied by full remittance for extra fare and Pullman are not received by that date, the train will be abandoned and all remittances returned. If the train runs, no remittances will be returned for any cause, as they are part of the guarantee.

Industrial Developments of the Week Marked by Production Increases

Paper.—The Riverside Paper Co., Glastonbury, Conn., has increased production to a full-time operating schedule at its local mill. Orders on hand are said to insure capacity operation for at least 2 months.

The United Paper Board Co., Whippany, N. J., is arranging for the immediate resumption of operations at its Hanover mill, which has been shut down for about a year past. A large working force is being recruited.

The Eastern Manufacturing Co., Bangor, Me., is operating its paper mills at capacity, and reports that incoming orders are running at about 110 per cent of rated production. The pulp department of the company is operating at about 65 per cent of normal.

Leather.—The Dietz Leather Co., Lynn, Mass., is completing a new beam house at its tannery and plans to place the structure in service at once. The capacity will be increased by about 300 dozen skins a day.

Every leather plant at Wilmington, Del., is now in operation and a new tannery at South Wilmington will commence operations at an early date. One of the largest local plants is now soaking 1,400 to 1,600 skins per day, or more than double the average daily amount during the year past.

The Greiss-Pfleger Tanning Co., is operating its two plants at Chicago, Ill., and Waukegan, Ill., at full capacity.

The Widen-Lord Tanning Co., Danversport, Mass., is operating its plant at capacity, with daily production totaling about 3,500 hides.

The Northwestern Leather Co., Boston, Mass., is operating at all of its tanneries at full capacity, including the plants at Portville, N. Y., Sault Ste. Marie and Manistique, Mich.

Ceramic.—The Maddock Pottery Co., Trenton, N. J., manufacturer of chinaware, is operating at full capacity, and has orders ahead to maintain operations indefinitely.

The Glen-Gery Shale Brick Co., Reading, Pa., has made a number of extensions and improvements in its plant to increase the production to more than 210,000 bricks per day. Capacity operations will be maintained.

Glass.—The Greensburg Glass Co., Greensburg, Pa., has resumed production at its plant after a shut-down of several months. Capacity operations are planned throughout the summer.

Six general glass plants in the Charleston, W. Va., district have resumed operations, giving employment to about 1,500 men. Three window glass plants have also started up, employing approximately 850 men.

Tin.—The McKeesport Tin Plate Co., McKeesport, Pa., began operations under a full-time schedule on Feb. 12, for the first time in several weeks. The plant is giving employment to about 3,500 men.

The American Sheet & Tin Plate Co. is operating at thirty of the forty hot mills at its Shenango, Pa., works. At the Newcastle, Pa., plant, twelve of the twenty hot mills are in active service.

Iron and Steel.—The Gulf States Steel Co. has resumed operations at its blast furnace at Birmingham, Ala. The unit was blown in Feb. 7.

The British Empire Steel Corp., Glace Bay, Nova Scotia, has resumed operations at its local plant on a full-time schedule.

The Wheeling Steel Corporation, Wheeling, W. Va., has resumed operations at three mills at Yorkville, Ohio, effective Feb. 7. The plant has been closed since last June.

The Trumbull Steel Co., Youngstown, Ohio, is working at 90 per cent capacity at its different plants. The entire battery of ten tinplate mills at the Liberty plant is in operation.

The Inland Steel Co., Chicago, Ill., is planning to start its new rail mill at the East Chicago, Ind., works, on March 1, with initial production on a 70 per cent basis. The mill will have a capacity of about 15,000 tons of finished rails per day.

Copper.—The Phelps-Dodge Corporation has placed three copper furnaces in operation at its Copper Queen smelter, Douglas, Ariz.

The Calumet & Arizona Mining Co. has resumed operations at two reverberatory furnaces at its smelter at Douglas, Ariz.

Engineering Foundation Board Considers Steps to Encourage Research

At the meeting of the Engineering Foundation Board on Feb. 9, a communication from Byron E. Eldred, well-known mechanical engineer and inventor, was presented proposing the establishment of an organization for the encouragement and development of meritorious research and invention. It is proposed to establish a department under the direction of an experienced engineer to furnish to inventors information, advice and financial assistance, to examine suggestions and inventions offered, to develop ideas believed to be of value and to obtain patents for and commercialize inventions which have passed thorough examination. The proposal includes the formation of a board of review composed of eminent engineers, scientists and patent attorneys and a board on commercialization of inventions to be composed of business men, industrialists and bankers. It also suggests the formation of a large endowment fund, the income of which would support the work and which would be increased by participation in the emoluments of successful inventions.

The board referred Dr. Eldred's suggestion to a committee of four consisting of Bancroft Gherardi, H. Hobart Porter, E. D. Adams and John H. Barr.

Sectional Meeting American Society for Steel Treating

Members of the New England and Seaboard Chapters of the American Society for Steel Treating will hold a sectional meeting at the Hotel McAlpin, New York City, on Friday, March 3. Technical sessions will be held at 2 and 8 p. m., and an informal dinner will be served at 6 o'clock. Papers on "Cold-Headed Bolts," "Influence of Mass in Heat-Treatment," "Magnetic Testing of Chain," "Stainless Steel," "A New Heat-Treating Alloy," "Perfecting a Drop Forging" and "The Manufacture of Steel" will be read and discussed.

All those interested in metallurgy and heat-treatment of steel are cordially invited to attend, whether members of the society or not.

Personal

E. T. ALLEN of the Geophysical Laboratory, Washington, D. C., addressed the Chemical Society of Washington on "Chemical Aspects of Volcanism" at the regular meeting of the section on Feb. 9.

S. E. BEACH has been re-elected president of the Sun Oil Co. of California, Los Angeles, Cal.

F. E. CARROLL, former representative of the Goodyear Tire & Rubber Co. in San Francisco, has been appointed Pacific Coast manager for the New York Lubricating Oil Co., with headquarters in San Francisco.

Dr. H. S. DAVIS has resigned his industrial fellowship at the Mellon Institute of Industrial Research, Pittsburgh, Pa., to accept a position on the research staff of Arthur D. Little, Inc., of Cambridge, Mass.

ARNOLD M. EASTMAN is now in charge of all chemical work at the plant of the Upson Co., Lockport, N. Y.

CHARLES H. ELDRIDGE is now with the non-ferrous metallurgy section of the Bureau of Mines, Pittsburgh, Pa. For the past 4 years he was associated with Dr. C. G. Fink in the development of an insoluble anode now used by the Chile Exploration Co.

G. V. GEISLER, export manager for the American Vulcanized Fiber Co., Wilmington, Del., has been appointed chairman of the Southern States committee of the Export Managers Club of New York.

GROSVENOR M. JONES, who before 1913 was engaged in a special investigation in Washington in behalf of the American Paper and Pulp Association and since then has been with the Bureau of Foreign and Domestic Commerce, has taken charge of the latter's new paper division. He was assistant director of the Bureau of Foreign and Domestic Commerce from February, 1918, to August, 1919.

WARREN A. KING, president of the King Chemical Co., Bound Brook, N. J., has been re-elected president of the Manufacturers' Council of the State of New Jersey.

ERIC A. LOF, industrial engineer and specialist of the power and mining engineering department of the General Electric Co., had the Royal Order of Vasa conferred on him by the King of Sweden, in recognition of meritorious service to his government.

Prof. J. H. MATHEWS, chairman of the department of chemistry, University of Wisconsin, addressed the Purdue Section of the American Chemical Society, Feb. 9, on the subject "Some of the Research Methods and Research Problems of Photochemistry."

HERMAN C. MUELLER, head of the Mueller Mosaic Co., Trenton, N. J., gave an interesting address before students of the local Industrial Art School and other guests in the auditorium at the institution, Feb. 8, on the subject of "Industrial Training From the Standpoint of the Manufacturer and the Workman."

C. W. SUTTON has been re-elected president of the American Vulcanized Fiber Co., Wilmington, Del.

HERBERT TALLEY, chief engineer of the Hercules Powder Co., has resigned his position to become the operating head of the United States Powder Co. of Terre Haute, Ind.

H. G. THIELE, formerly with the Oliver Continuous Filter Co., is now connected with the Engineering Structures Co., Call Building, San Francisco, specializing on structural erection.

Dr. J. C. WITT, of Chicago, has been called into consultation by the Bureau of Mines to co-operate in research on portland cement-manufacturing processes.

Obituary

WILLIAM A. BARSTOW, president of the Union Tank Car Co., New York, died recently at his home in West Orange, N. J., of pneumonia.

WILLIAM JAMES COMSTOCK, for many years instructor in organic chemistry at the Sheffield Scientific School of Yale University, died Jan. 24, at St. Raphael's Hospital, New Haven, Conn., after an illness of 5 weeks. He was born at Toledo, Ohio, June 15, 1860; was graduated from Sheffield Scientific School in the Class of '79, was a Fellow in Chemistry at Johns Hopkins in 1881, and from 1882 to 1887 studied in Germany at the University of Munich. On his return to the United States he became an instructor at Yale, where he spent most of the active portion of his life.

WILLIAM H. GOULD, president of the Hoboken Paper Mill Co., Hoboken, N. J., died Feb. 4, following an illness of many months. He was sixty-eight years of age.

WILLIAM C. SARGENT, for 22 years secretary and also a director of Chain Belt Co., Milwaukee, Wis., died suddenly on Feb. 5 as the result of heart failure. He was seventy-three years of age and had been in ill health for several years. Mr. Sargent, prominent in industrial circles of Milwaukee and St. Paul, had a wide national acquaintanceship. He was born at Troy, N. Y., Feb. 2, 1849. In 1871 he moved west, locating at St. Paul, where he organized the De Cou, Corliss & Sargent Co., manufacturer of sash and doors. He later became affiliated with the St. Paul Harvester Co., and met C. W. Le Valley, who later founded the Chain Belt Co. of Milwaukee. This meeting was the beginning of a long business association, for in 1900 Mr. Sargent went to Milwaukee to become secretary and later a director of the Chain Belt Co. He was also a director of the Federal Malleable Co., West Allis, Wis. His father was one of the founders of the Terre Haute, Alton & St. Louis R.R. Mr. Sargent established many of the early business connections of the Chain Belt Co., a large number of which are still among the company's jobbers.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

Annual Reports and Financial Statements

We are now in the midst of the season of annual reports. The columns of the business papers are crowded with figures from financial statements and consolidated balance sheets. Such compilations of profit and loss and assets and liabilities in themselves mean but little to the uninitiated, but to the stockholder, banker or investor for whom they are intended they offer a ready means for appraising the stability of a company's finances. To the average engineer they may be almost void of meaning, but the financier familiar with the companies' policies uses them as an accurate check upon efficiency in operation and management.

At this time, perhaps more than any other, is the layman finding it difficult intelligently to interpret business statistics. The terrific decline in commodity prices has often necessitated radical revision of company policies. Inventories have had to be written down to replacement values. Stocks of finished goods have had to be carried at current manufacturing costs. Properties have had to be evaluated at a time when actual market values are probably nonexistent.

The condensed income statement derives its principal value as an index of general tendencies. However, in these days of business depression, comparison with previous years has lost much of its significance. Some sort of mental correction has to be made for relative values. The same thing that applies to inventories is equally applicable to reserves and to accounts payable and receivable. Furthermore, shutdown expenses, excessive depreciation and many other unusual items figure prominently in this year's balance sheets.

According to the policy pursued by some companies, it is customary to furnish stockholders and the general public with summarized reports of the year's activities in production and distribution. These are usually of real value to those interested in the general study of business conditions in the different industries.

During the past week a number of prominent chemical and metallurgical firms have made public the reports of their operations during 1921. Statements taken from some of these of more general interest are summarized in the following paragraphs.

The Hercules Powder Co.

The Hercules Powder Co. is one of the companies whose annual financial statement is accompanied by an illuminating explanatory report. Thus at the close of its ninth year, President R. H. Dunham of the Hercules company has presented a consolidated report showing the 1921 operations of that company, together with its subsidiaries, the Yaryan Rosin & Turpentine Co. and the Hercules Explosives Corporation of New York. The last-named corporation represents the entire assets and business of the former Aetna Explosives Co., Inc.

New Facilities Established

"This purchase," says President Dunham, "brought to the Hercules company manufacturing facilities and established business equal to approximately one-half its own in dynamite and one-quarter in black blasting powder. Also new facilities were obtained for the manufacture of blasting caps sufficient to supply not only the business acquired from the Aetna company but also all such requirements formerly purchased from other manufacturers." Furthermore, these manufacturing facilities are now so favorably located that it is possible to compete in the markets of practically every state in which there is a substantial consumption of explosive materials.

Naval Stores Division

In referring to the manufacture of naval stores—rosin, turpentine and pine oil—President Dunham reported that the company's plants were shut down early in 1921 with stocks sufficient to supply customers' reduced requirements for several months. During September the plant at Brunswick, Ga., was put into operation and this branch of the company's business is now operating without loss notwithstanding the very low prevailing prices, which are generally conceded to be below the cost of production by the ordinary method of obtaining rosin and turpentine from the living trees.

The Year's Profits

"Largely as a result of such economies," says the report, "as well as reductions in salaries and wages, the quarterly statements have shown steady improvement from a net deficit before the preferred dividend in the first quarter to the earning in the last quarter of a slight excess over the quarterly common dividend paid in December."

The Hercules company still retains at the close of 1921 a profit and loss surplus double its outstanding common capital stock, notwithstanding that the common dividends for the first three quarters were paid out of previously accumulated surplus. Because of the conservative dividend policy in the period of large earnings during the early war years and the accumulation of this large surplus equity belonging to the common stock the directors have felt that the common dividend should be continued while the company's financial position permitted, even though, for a reasonable time, the current net earnings should fail to equal such dividends.

Annual Earnings and Dividends

The amounts available for dividends and those paid on common stock, together with the net earnings on the investments, are shown in the following table adapted from the company's financial statement:

Year	Available for Dividend Equivalent to Annual Rate on Common Stock, Per Cent	Dividends Paid During Period on Common Stock, Per Cent	Net Earnings From All Sources Equivalent to Annual Rate on Total Investment, Per Cent
1913	15.65	3.00	9.52
1914	14.32	8.00	8.55
1915	63.18	16.00	13.97
1916	227.75	95.00	46.54
1917	76.19	70.00	17.88
1918	27.15	17.00	5.43
1919	16.86	16.00	5.09
1920	1.02	16.00	1.57
1921	3.48	12.00	2.19

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base=100 for the year July 1, 1913, to June 30, 1914

This week	149.05
Last week	147.46
February, 1921	166
February, 1920	252
April, 1918 (high)	286
April, 1921 (low)	140

The phenomenal increase in the price of linseed oil from 78c. to 86c. per gal. and a lesser rise in cottonseed oil are directly responsible for this week's higher index number. Slightly lower prices were reported for methanol, formaldehyde, caustic soda and crude potassium carbonate.

International Nickel Co.

The International Nickel Co. reported a deficit, after charges and federal taxes, of $641,678.11 for the 9 months ended with the calendar year. This is to be compared with net profits of $2,620,873 earned on the $41,834,600 of common stock in the corresponding period in 1920. Earnings were $143,714, as against $4,415,774 in the preceding year. Accounts payable, including tax reserves, amounted to $1,122,977, compared with $1,786,674.

The consolidated general profit and loss statement for the 9 months ended Dec. 31, 1921, follows:

Earnings		$143,713.96
Other income		220,560.73
Total income		$364,274.69
Administration and general expense	$311,874.17	
Reserved for United States and foreign taxes	70,128.01	382,002.18
Net income (deficit)		$17,727.49
Maintenance and shutdown expense of plants not operating	$228,266.09	
Depreciation and mineral exhaustion	395,684.53	623,950.62
Deficit		$641,678.11
Dividends		$401,067.00
Balance (deficit)		$1,042,745.11

Armour Leather Co.

The annual report of the Armour Leather Co. shows a deficit of $7,564,196 for the year 1921. This compares with a deficit of $4,313,653 in the previous year.

In his report to the stockholders, President Henry W. Boyd calls attention to the company's conservative policy in the purchasing of hides during the period of highly inflated prices. In this connection he continues: "We made the largest purchases of hides in our history in April, 1921, at the lowest prices prevailing in 15 years, and have been in the market often since.

"Our Sheboygan plant, which was destroyed in January, 1920, was rebuilt last year and resumed operations during 1921, its output meeting excellent demand.

"With our hides inventoried at cost and leather at the market, we made an operating profit during the last quarter of $869,000. The first quarter of this year will also show an operating profit. We are of the opinion that the hide and leather markets are sound and the remaining three-quarters of 1922 will show profits."

United States Rubber Co.

In a letter to the stockholders of the United States Rubber Co., C. B. Seger, chairman of the board of directors, declared that the annual report of the company will show a net profit of $470,817. This is in spite of a decrease of approximately $18,000,000 in the income from sales, caused by the drastic reduction in prices made after Jan. 1, 1921.

Mr. Seger stated that the volume of the company's business during 1921, expressed in tonnage rather than in dollars, was entirely satisfactory in view of the general business depression.

"The company closed the year in a strong financial condition," he continued. "Substantial liquidation having been effected, overhead expenses having been reduced to the minimum consistent with efficient operations, the company is in a strong position to meet the future."

Foreign Trade of the United Kingdom in 1921

The value of imports and exports of chemicals and allied products for Great Britain during 1920 and 1921 are shown in the following table taken from the *Official Board of Trade Journal* of Jan. 19, 1922.

Classification	Imports c.i.f. Value £1,000 Sterling 1920	1921	Exports of British Manufacture f.o.b. Value £1,000 Sterling 1920	1921
Chemicals, drugs, dyes and colors	34,329.5	12,682.2	40,535.7	19,057.3
Oils, fats and resins	76,853.3	56,589.2	13,626.4	5,230.4
Leather, and manufactures of	20,445.1	8,666.5	11,664.9	4,760.5
Paper and cardboard	30,243.7	11,601.3	12,810.4	7,736.4
Rubber goods	7,102.5	4,919.7	11,520.2	4,662.4
Earthenware, glass and abrasives	11,113.2	7,014.3	18,290.7	12,080
Iron and steel and manufactures of	29,016.7	22,887.4	128,907.4	63,772.4
Non-ferrous metals and manufactures of	39,132.6	18,467.6	25,781.8	11,733.7

The New York Market

NEW YORK, Feb. 20, 1922.

Interest in the chemical market during the past week has been limited to special items. Foreign buying has featured these commodity markets and there has been an appreciable increase in the aggregate volume of export sales. Dealers in caustic soda have been successful in obtaining a considerable portion of this business and sales were reported to Japan, Italy and South American countries. The advancing exchange has apparently broadened the field for export business. Copper sulphate is another item that has been sold in quantities sufficient to tax the capacities of leading producers. Italy and Greece are large buyers at present. Some small transactions were recorded to South America and are very significant because these countries have practically ignored American blue vitriol during the past year.

GENERAL CHEMICALS

Arsenic—Dealers report odd-lot sales in this item at 7@7¼c. per lb. on spot. Producers are not very anxious to shade 7¼c. and report moderate orders at this figure. The present market, as a whole, is in a very healthy position, owing to the scant supplies and higher prices abroad.

Bleaching Powder—Producers quote the market at 2@2¼c. per lb. for large drums f.o.b. works. The demand has shown some improvement and the general market is firmer.

Bichromate of Potash—Leading factors are lower in their views and quote the market at 10½@10¾c. per lb.

Bichromate of Soda—Dealers were not anxious to quote below 7¾c. per lb. for spot material at the close of trading, with the general range around 7¾@8c. per lb. A fairly active call was noted to the consuming trades.

Carbonate of Potash—While some importers are quoting the 80-85 per cent material at 4@4¼c. per lb., others are shading this figure and are offering spot goods as low as 3¾c. Activity in this item has been very dull since the beginning of the year and keener competition has arisen.

Caustic Soda—Export inquiries continue to reach the market and sales are going through, but the majority of these are for small quantities. Leading dealers quote $3.25 per 100 lb. f.a.s. New York and in some quarters it was intimated that a shade under this figure might be done on business of a sizable proportion. Prices remain unchanged at the works.

Copper Sulphate—The demand for this chemical has improved during the past week. Export inquiries have reached the market and some of the larger producers have booked considerable business with Greece and Italy. American producers have been able to procure this business only through very close bidding. The domestic inquiry has not been very active, although the farmers are expected to come into the market in the near future. The general tone is firm with prices unchanged.

Nitrite of Soda — This chemical has been one of the leading features of the week's activities. Absorption of spot supplies has strengthened the market and some of the largest sellers have withdrawn from the market. While odd lots could possibly be purchased in a limited way at 7¼c. per lb., producers are firm at 7½c. The demand has shown considerable activity.

Prussiate of Soda—The limited spot supplies and improved demand have created a stronger market for this product and it is very doubtful if better than 18½c. per lb. could be done at present. February shipment was quoted at 17¾c. and March shipment at 17c. per lb. c.i.f. New York.

Soda Ash—Dealers report few inquiries on spot. Light ash in bags is offered in carload lots at $1.65 per 100 lb. and in barrels at $7.90. Smaller quantities demand a higher price. Producers quote light ash at $1.27½ per 100 lb. in single bags, basis 48 per cent, f.o.b. works.

Linseed Oil—Owing to the strengthened position of flaxseed, linseed oil took a sensational rise during the past few days and advanced during the week from 78c. to 86c. per gal. Imported material has been difficult to locate at any reasonable figure and as a result buyers were not inclined to purchase either domestic or foreign goods at the high prices.

The St. Louis Market

ST. LOUIS, Feb. 16, 1922.

There are no developments of great importance to mention at this time. Conditions in this market continue on the road to improvement. Confidence is gradually being restored, and buyers are more liberally inclined in covering their requirements. There have been very few price changes during the last period, and the general trend of the market is upward.

Alkalis—There is a slight decline on caustic soda. Carloads, 76 per cent, solid, are quoted at $3.40 per 100 lb., f.o.b. point of production, but 1- to 10-drum lots can be had for $4@$4.10 f.o.b. consumer's door. Flake, 76 per cent, in carloads is $3.75, f.o.b. point of production, with the 1- to 10-drum lots at $4.40@$4.50 per 100 lb., f.o.b. consumer's door. Light soda ash, 58 per cent, is still to be had at the previous price $2.40@$2.75 in less than carlots, carloads at about $1.85 f.o.b. point of production. Sal soda shows no change either in demand or price, and is quoted at $2@$2.25 per 100 lb. Bicarbonate of soda is moving slowly at the same price of $2.75 per 100 lb. in barrels.

General and Special Chemicals—While the demand for citric acid since the decline has not shown any great improvement, the season for this material is opening and larger stock should be carried. Acid gallic and pyrogallic continue to be quite active. Acid tartaric is again coming to life with prices firm. White arsenic is being quoted in carlots at 7c. St. Louis with one producer sold up. The increase in the demand for bromides is noticeable and orders of larger volume are passing. Ammonia water, 26 deg. U.S.P. is moving through regular channels. Carbon bisulphide prices are very firm with a brisk demand. The decline in prices on carbon tetrachloride about 2 weeks ago has not stimulated buying to a great extent, the demand being routine. The market on copperas remains the same, and the demand is still beyond manufacturers' output. Glycerine continues firm and in good demand at 16½c. in drums for spot goods; practically nothing is being done in the way of contracts. Owing to the continued increase in the sterling exchange, manufacturers advanced their prices yesterday on all iodide salts, with demand very good. Zinc sulphate is still being quoted at 3@3½c. per lb., f.o.b. point of production, with a fair demand.

Vegetable Oils and Naval Stores—The vegetable oil market shows a very firm condition with no declines, and stiff advances in linseed oil, which is now being held at 89c. basis raw oil, no futures accepted. Castor oil continues firm and in good demand at 13c. per lb. in drums. Turpentine is quoted at 96½c. in single barrels for pure gum spirits, the lowest price since our last report having been 93½c.

Paint Materials—Conditions in the barytes market remain practically as they were, so far as price is concerned, but there is improvement in the demand. Prices are quoted at $23@$25, cooperage included, f.o.b. St. Louis, for highest grade water-floated material. Domestic lithopone is apparently coming into its own again. Local producers report that they are practically out of stock, while a year ago stocks on hand were considerable. Zinc oxide is improving slightly, with demand fair and no price changes reported.

The Iron and Steel Market

PITTSBURGH, Feb. 17, 1922.

A particularly sharp increase in steel production occurred this week, the present rate being certainly well above 26,000,000 tons a year, and possibly as much as 28,000,000 tons. Our last report indicated that the average rate during January was about 22,750,000 tons.

There has been a very moderate increase in demand for practically all steel products since the first of the year. The particular jump in production this week seems to be due in part to the scheduling of rail mills in the Pittsburgh and Chicago districts to a good rate, caused not by strictly new buying but rather by specifying against contracts placed several months ago. There is also increased production of steel against orders for cars placed in 1921.

A point in analysis of the steel situation, as pointed out last week, is that in general the buying of steel is for very prompt shipment, and hence the best measure of market activity is the rate of steel mill operation. This can be estimated as a total, while the synthesis of market activity in different steel products, among different classes of consumers and in different parts of the country, is naturally not very precise. Technically, a disturbing element is this production of railroad material, since it does not represent hand-to-mouth buying as is the case with other steel products, hence cannot be counted upon with the same certainty.

Were it not for this element, the fact that steel ingot production has probably reached a rate of close to 28,000,000 tons a year would be of transcending importance. Production was at 11,000,000 tons a year last July, and rose, with the autumn demand, to 23,000,000 tons in October and November. A jump to a point so much higher, when spring is still several weeks distant, would indicate an extremely promising pace of improvement. No such continued rapid increase can be expected. With last autumn's demand measured by a 23,000,000-ton rate of ingot production, the industry may well be satisfied if it maintains an average rate, February to June inclusive, between 25,000,000 and 30,000,000 tons. The summer, no doubt, will be dull. Next autumn should bring a still higher tide.

STEEL PRICES

As indicated in previous reports, competition between mills became much keener just after the first of the year. The price competition did not consist, to any great extent, in naming new extremes for large orders, but was rather along the line of making concessions from regular prices for smaller orders. In bars, shapes and plates the regular or open market has been 1.50c. for more than 2 months, while the average price of all sales has been falling. Concessions have now extended to such small orders that the general market is more properly quotable at 1.40c. than at 1.50c., a price now reserved for small orders. Concessions below 1.40c. are altogether exceptional, but using the price as a general Pittsburgh basis there are departures in various sections, representing really a departure from Pittsburgh basing. The seller realizes, f.o.b. his mill, more than the Pittsburgh price, but does not get the full advantage of his location as he did when selling on the "Pittsburgh plus" system. Thus some Eastern mills have sold at above 1.50c. f.o.b. mill, when the same delivered price would have netted the Pittsburgh mill less than 1.40c.

Sheet prices are very well maintained at 2.25c. for blue annealed except in case of the heaviest gages, 3c. for black and 4c. for galvanized. This price steadiness has been one of the market phenomena for more than two months. Nails continue to be shaded to $2.40 in the case of large buyers, but mills insist that $2.50 is being obtained from the smaller buyers. Standard steel pipe is being shaded by 2½ to 5 per cent by most independents, this being to an extent a sort of trade custom.

PIG IRON

Despite a resale of basic pig iron on the basis of $17.75 valley recently, the producers seem strongly committed to maintaining the old price of $18. Bessemer remains at $19.50 valley, and is quite inactive. Foundry iron is not over-steady at its price of $19 valley. Jackson county furnaces have reduced bessemer ferrosilicon and silvery irons $2 a ton. These irons do not come to the Pittsburgh district to any extent, the preference being for the 50 per cent electrolytic, one advantage of which is that the buyer does not need to pay freight on a large percentage of iron.

Connellsville coke, reported a week ago as stiffening, has undergone a sharp advance, due to an actual demand developing in a situation which had secured a firm foundation. It is reported that a purchase of 75 carloads of prompt furnace coke has been made at $3.25 and another of 50 carloads at $3.50, the buyers, of course, being furnaces, while the market previously had been depending on the small-lot buying of miscellaneous consumers. Foundry coke is quotable at $4@$4.25, against $3.75@$4.25 formerly quoted. Dover furnace, Dover, Ohio, which blew in yesterday, contracted for its coke to July 1 at $3.25.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	..... –	$0.40 – $0.42
Acetone	lb.	$0.12½– $0.12½	.13 – .13½
Acid, acetic, 28 per cent	100 lbs.	2.50 – 2.60	2.65 – 3.00
Acetic, 56 per cent	100 lbs.	5.00 – 5.25	5.30 – 5.50
Acetic, glacial, 99½ per cent, carboys,	100 lbs.	9.00 – 9.50	9.75 – 10.00
Boric, crystals	lb.	.12½– .12¾	.13 – .13½
Boric, powder	lb.	.12½– .13	.13½– .14
Citric	lb.	..... –	.44 – .45
Hydrochloric	100 lb.	1.15 – 1.25	1.30 – 1.75
Hydrofluoric, 52 per cent	lb.	.11 – .11½	.11½– .12
Lactic, 44 per cent tech	lb.	.09½– .10	.10½– .12
Lactic, 22 per cent tech	lb.	.04 – .04½	.04½– .05
Molybdic, c.p.	lb.	3.00 – 3.25	3.30 – 3.75
Muriatic, 20 deg. (see hydrochloric)		..... –	..... – .....
Nitric, 40 deg	lb.	.06½– .06¾	.06½– .07
Nitric, 42 deg	lb.	.06½– .07	.07½– .07¾
Oxalic, crystals	lb.	.14 – .14½	.14½– .15½
Phosphoric, 50 per cent solution	lb.	.08 – .08½	.08½– .09½
Picric	lb.	.20 – .25	.27 – .35
Pyrogallic, resublimed	lb.	..... –	1.65 – 1.75
Sulphuric, 60 deg., tank cars	ton	10.00 – 11.00	..... – .....
Sulphuric, 60 deg., drums	ton	12.00 – 14.00	..... – .....
Sulphuric, 66 deg., tank cars	ton	16.00 – 16.50	..... – .....
Sulphuric, 66 deg., drums	ton	20.00 – 20.50	21.00 – 22.00
Sulphuric, 66 deg., carboys	ton	..... –	..... – .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19.50 – 20.00	..... – .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22.00 – 22.50	23.00 – 24.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 – 32.00	33.00 – 34.00
Tannic, U. S. P.	lb.	..... –	.65 – .75
Tannic (tech.)	lb.	.45 – .50	.51 – .55
Tartaric, imported crystals	lb.	..... –	.25½– .27
Tartaric acid, imported, powdered	lb.	..... –	.26 – .29
Tartaric acid, domestic	lb.	..... –	..... – .30
Tungstic, per lb. of WO	lb.	..... –	1.00 – 1.10
Alcohol, ethyl	gal.	..... –	4.75 – 5.50
Alcohol, methyl (see methanol)		..... –	..... – .....
Alcohol, denatured, 188 proof No. 1	gal.	..... –	.36 – .37
Alcohol, denatured, 188 proof No. 5	gal.	..... –	.36 – .37
Alum, ammonia, lump	lb.	.03½– .03¾	.04 – .04½
Alum, potash, lump	lb.	.03½– .04	.04½– .04¾
Alum, chrome lump	lb.	.07½– .08	.08½– .08¾
Aluminum sulphate, commercial	100 lb.	1.65 – 1.85	1.90 – 2.40
Aluminum sulphate, iron free	lb.	.02½– .02¾	.03 – .03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½– .07¾	.08 – .08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .30½	.31 – .33
Ammonium carbonate, powder	lb.	.07 – .07½	.08 – .09
Ammonium nitrate	lb.	.06½– .07	.07½– .07¾
Amylacetate tech	gal.	..... –	2.00 – 2.40
Arsenic, white, powdered	lb.	.07½– .07¾	.07½– .08½
Arsenic, red, powdered	lb.	.12 – .12½	.12½– .13
Barium chloride	ton	57.00 – 58.00	59.00 – 70.00
Barium dioxide (peroxide)	lb.	.21 – .21½	.22 – .23
Barium nitrate	lb.	.06½– .07	.07½– .08½
Barium sulphate (precip.) (blanc fixe)	lb.	.03½– .04	.04½– .04½
Blanc fixe, dry	lb.	.04 – .04½	..... – .....
Blanc fixe, pulp	ton	45.00 – 55.00	..... – .....
Bleaching powder	100 lb.	2.00 – 2.25	2.30 – 3.25
Blue vitriol (see copper sulphate)		..... –	..... – .....
Borax	lb.	.05½– .05½	.06 – .06½
Brimstone (see sulphur, roll)		..... –	..... – .....
Bromine	lb.	.20 – .21	.21½– .26
Calcium acetate	100 lbs.	1.75 – 2.00	..... – .....
Calcium carbide	lb.	.04½– .04½	.05 – .05½
Calcium chloride, fused, lump	ton	24.00 – 24.50	24.75 – 27.00
Calcium chloride, granulated	lb.	.01½– .02	.02½– .02½
Calcium peroxide	lb.	..... –	1.40 – 1.50
Calcium phosphate, tribasic	lb.	..... –	.15 – .16
Camphor	lb.	..... –	.94 – .96
Carbon bisulphide	lb.	.06 – .06½	.06½– .07½
Carbon tetrachloride, drums	lb.	.10½– .10½	.11 – .12
Carbonyl chloride, (phosgene)	lb.	..... –	.60 – .75
Caustic potash (see potassium hydroxide)		..... –	..... – .....
Caustic soda (see sodium hydroxide)		..... –	..... – .....
Chalk, precip.—domestic, light	lb.	.04½– .04½	..... – .....
Chalk, precip.—domestic, heavy	lb.	.03½– .03½	..... – .....
Chalk, precip.—imported, light	lb.	.04½– .05	..... – .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.06 – .06½	.06½– .07
Chloroform	lb.	..... –	.39 – .43
Cobalt oxide	lb.	..... –	2.00 – 2.10
Copperas	ton	15.00 – 16.00	16.50 – 20.00
Copper carbonate, green precipitate	lb.	.19 – .20	.20½– .21
Copper cyanide	lb.	..... –	.58 – .60
Copper sulphate, crystals	100 lb.	5.55 – 5.65	5.70 – 6.25
Cream of tartar	lb.	..... –	.23 – .24½
Epsom salt (see magnesium sulphate)		..... –	..... – .....
Ethyl acetate com. 85%	gal.	..... –	.60 – .65
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	..... –	.93 – .....
Formaldehyde, 40 per cent	lb.	.09½– .10	.10½– .11
Fullers earth, f.o.b. mines	net ton	16.00 – 17.00	..... – .....
Fullers earth—imported powdered—net ton		30.00 – 32.00	..... – .....
Fusel oil, ref	gal.	..... –	2.50 – 3.00
Fusel oil, crude	gal.	..... –	1.40 – 1.75
Glauber's salt (see sodium sulphate)		..... –	..... – .....
Glycerine, c. p. drums extra	lb.	..... –	.16½– .17
Iodine, resublimed	lb.	..... –	3.80 – 3.90
Iron oxide, red	lb.	..... –	.12 – .18
Lead acetate	lb.	..... –	.10½– .12½
Lead arsenate, powd	lb.	.15 – .15½	.15½– .16½
Lead nitrate	lb.	..... –	.15 – .20
Litharge	lb.	.07½– .07½	.08 – .08½
Magnesium carbonate, technical	lb.	.06 – .06½	.06½– .08
Magnesium sulphate, U. S. P.	100 lb.	2.65 – 2.70	2.75 – 3.00
Magnesium sulphate, technical	100 lb.	..... –	1.05 – 1.80
Methanol, 95%	gal.	..... –	.56 – .57
Methanol, 97%	gal.	..... –	.58 – .59
Nickel salt, double	lb.	..... –	.11 – .11½
Nickel salt, single	lb.	..... –	.11 – .11½
Phosgene (see carbonyl chloride)		..... –	..... – .....
Phosphorus, red	lb.	.45 – .46	.47 – .50
Phosphorus, yellow	lb.	..... –	.30 – .35

		Carlots	Less Carlots
Potassium bichromate	lb.	.10½– .10¾	.10½– .10¾
Potassium bromide, granular	lb.	..... –	.13 – .17
Potassium carbonate, U. S. P.	lb.	.12 – .12½	.13 – .16
Potassium carbonate, 80–85%	lb.	.04 – .04½	.04½– .05½
Potassium chlorate, crystals	lb.	.05½– .06	.06½– .08
Potassium cyanide	lb.	..... –	.42 – .45
Potassium hydroxide (caustic potash)	100 lb.	5.65 – 5.75	5.80 – 6.50
Potassium iodide	lb.	..... –	2.90 – 3.00
Potassium nitrate	lb.	.07½– .07½	.08 – .09
Potassium permanganate	lb.	.13 – .14	.14½– .22
Potassium prussiate, red	lb.	nominal	nominal
Potassium prussiate, yellow	lb.	.25 – .25½	.25½– .26½
Rochelle salts (see sodium potas. tartrate)		..... –	..... – .....
Salammoniac, white, granular	lb.	.06½– .07	.07½– .07½
Salammoniac, gray, granular	lb.	.06½– .06¾	.07 – .07½
Salsoda	100 lb.	1.60 – 1.70	1.75 – 2.00
Salt cake (bulk)	ton	17.00 –20.00	..... – .....
Soda ash, light	100 lb.	1.65 – 1.80	1.85 – 2.40
Soda ash, dense	100 lb.	1.75 – 1.85	1.90 – 2.40
Sodium acetate	lb.	.04 – .04½	.04½– .05
Sodium bicarbonate	100 lb.	2.20 – 2.25	2.30 – 2.75
Sodium bichromate	lb.	.07½– .08	.08½– .08½
Sodium bisulphate (nitre cake)	ton	4.50 – 4.60	4.65 – 5.50
Sodium bisulphite powdered, U.S.P.	lb.	.04½– .04½	.04½– .05½
Sodium chlorate	lb.	.06½– .06½	.07 – .07½
Sodium chloride	long ton	12.00 –13.00	..... – .....
Sodium cyanide	lb.	.22½– .26	.26½– .27½
Sodium fluoride	lb.	.09½– .10	.10½– .11
Sodium hydroxide (caustic soda)	100 lb.	3.25 – 3.35	3.40 – 4.00
Sodium hyposulphite	lb.	.03½– .03½	.03½– .04
Sodium nitrite	lb.	.07½– .07½	.08 – .08½
Sodium peroxide, powdered	lb.	.28 – .30	.31 – .35
Sodium phosphate, dibasic	lb.	.03 – .04	.04½– .04½
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.18 – .21
Sodium prussiate, yellow	lb.	.18½– .13½	.18½– .19
Sodium silicate, solution (40 deg.)	100 lb.	.85 – 1.00	1.05 – 1.15
Sodium silicate, solution (60 deg.)	100 lb.	2.25 – 2.40	2.45 – 2.75
Sodium sulphate, crystals (glaubers salt)	100 lbs.	1.15 – 1.25	1.30 – 1.90
Sodium sulphide, fused, 60–62 per cent (conc.)	lb.	.04½– .04¾	.04½– .05
Sodium sulphite, crystals	lb.	.03½– .03¾	.03½– .04½
Strontium nitrate, powdered	lb.	.10 – .11	.11½– .15
Sulphur chloride, red	lb.	.05 – .05½	.05½– .06
Sulphur, crude	ton	18.00 –20.00	..... – .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	..... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	..... –	2.00 – 2.75
Talc—imported	ton	30.00 –40.00	..... – .....
Talc—domestic powdered	ton	18.00 –25.00	..... – .....
Tin bichloride	lb.	.09 – .09½	.09½– .10
Tin oxide	lb.	..... –	.39 – .40
Zinc carbonate	lb.	.14 – .14½	.14½– .15½
Zinc chloride, gran	lb.	.08 – .08½	.08½– .09
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc oxide, XX	lb.	.07½– .08	.08½– .08½
Zinc sulphate	100 lb.	3.00 – 3.25	3.30 – 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.00 — $1.05
Alpha-naphthol, refined	lb.	1.10 — 1.15
Alpha-naphthylamine	lb.	.28 — .30
Aniline oil, drums extra	lb.	.17 — .18
Aniline salts	lb.	.24 — .26
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.30 — 1.35
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb	.75 — .85
Benzoic acid, U.S.P.	lb.	.60 — .65
Benzoate of soda, U.S.P.	lb.	.55 — .57
Benzene, pure, water-white, in drums (100 gal.)	gal.	.29 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.27 — .32
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.60 — .65
Beta-naphthol, tech	lb.	.28 — .30
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 — .17
Ortho-cresol, in drums (100 lb.)	lb.	.20 — .22
Cresylic acid, 97-99%, straw color, in drums	gal.	.50 — .52
Cresylic acid, 95-97% dark, in drums	gal.	.45 — .47
Dichlorbensene	lb.	.06 — .09
Diethylaniline	lb.	1.00 — 1.10
Dimethylaniline	lb.	.41 — .45
Dinitrobensene	lb.	.21 — .25
Dinitroclorbensene	lb.	.25 — .27
Dinitronaphthalene	lb.	.32 — .35
Dinitrophenol	lb.	.35 — .38
Dinitrotoluene	lb.	.23 — .25
Dip oil, 25%, car lots, in drums	gal.	.25 — .28
Diphenylamine	lb.	.60 — .70
H-acid	lb.	.90 — 1.00
Meta-phenylenediamine	lb.	1.00 — 1.05
Monochlorbensene	lb.	.10 — .12
Monoethylaniline	lb.	1.15 — 1.20
Naphthalene crushed, in bbls.	lb.	.06½— .07
Naphthalene, flake	lb.	.06½— .07½
Naphthalene, balls	lb.	.07½— .08½
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17½
Ortho-amidophenol	lb.	2.75 — 2.80
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.15 — .20
Ortho-toluidine	lb.	.20 — .25
Para-amidophenol, base	lb.	1.25 — 1.30
Para-amidophenol, HCl	lb.	1.35 — 1.40
Para-dichlorbensene	lb.	.17 — .18
Paranitroaniline	lb.	.77 — .80
Para-nitrotoluene	lb.	.70 — .75
Para-phenylenediamine	lb.	1.55 — 1.60
Para-toluidine	lb.	1.10 — 1.15
Phthalic anhydride	lb.	.37 — .40
Phenol, U. S. P., drums	lb.	.12 — .16

Pyridine	gal.	1.75 —	2.75
Resorcinol, technical	lb.	1.25 —	1.50
Resorcinol, pure	lb.	1.85 —	2.00
Salicylic acid, tech., in bbls.	lb.	.18 —	.20
Salicylic acid, U. S. P.	lb.	.22 —	.23
Salol	lb.	.80 —	.82
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 —	.28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.12 —	.14
Sulphanilic acid, crude	lb.	.26 —	.28
Tolidine	lb.	1.20 —	1.30
Toluidine, mixed	lb.	.32 —	.38
Toluene, in tank cars	gal.	.25 —	.28
Toluene, in drums	gal.	.30 —	.35
Xylidines, drums, 100 gal.	lb.	.40 —	.45
Xylene, pure, in drums	gal.	.40 —	.45
Xylene, pure, in tank cars	gal.	.45 —	....
Xylene, commercial, in drums, 100 gal.	gal.	.33 —	.35
Xylene, commercial, in tank cars	gal.	.30 —	....

Waxes

Prices based on original packages in large quantities.

Bayberry Wax	lb.	$0.20 —	$0.21
Beeswax, refined, dark	lb.	.24 —	.25
Beeswax, refined, light	lb.	.28 —	.30
Beeswax, white pure	lb.	.34 —	.38
Candelilla wax	lb.	.24 —	.25
Carnauba, No. 1	lb.	.45 —	.46
Carnauba, No. 2, North Country	lb.	.22 —	.22½
Carnauba, No. 3, North Country	lb.	.14½ —	.15
Japan	lb.	.19 —	.20
Montan, crude	lb.	.04½ —	.05
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.04½ —	.04¾
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02½ —	....
Paraffine waxes, refined, 118-120 m.p.	lb.	.03 —	.03½
Paraffine waxes, refined, 125 m.p.	lb.	.03½ —	.03¾
Paraffine waxes, refined, 128-130 m.p.	lb.	.04 —	.04¼
Paraffine waxes, refined, 133-135 m.p.	lb.	.04½ —	.05
Paraffine waxes, refined, 135-137 m.p.	lb.	.05½ —	.05½
Stearic acid, single pressed	lb.	.08½ —	.09
Stearic acid, double pressed	lb.	.09½ —	.09½
Stearic acid, triple pressed	lb.	.10¼ —	.10¼

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.	280 lb.	$5.30	—	5.35
Rosin E-I	280 lb.	5.40	—	5.45
Rosin K-N	280 lb.	6.05	—	6.80
Rosin W. G.-W. W.	280 lb.	7.00	—	7.25
Wood rosin, bbl.	280 lb.	6.25	—	.....
Spirits of turpentine	gal.	.90	—	.....
Wood turpentine, steam dist.	gal.	.87½	—	.....
Wood turpentine, dest. dist.	gal.	.86½	—	.....
Pine tar pitch, bbl.	200 lb.	.....	—	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	.....	—	10.00
Retort tar, bbl.	500 lb.		—	9.00
Rosin oil, first run	gal.	.36	—	.....
Rosin oil, second run	gal.	.39	—	.....
Rosin oil, third run	gal.	.46	—	.....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.			$1.90
Pine oil, pure, dest. dist.	gal.			1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.			.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.			.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.			.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.			.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.			1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.			.35
Pinewood creosote, ref.	gal.			.52

Fertilizers

Ammonium sulphate, bulk	100 lb.	$2.50	—	2.60
Blood, dried, f.o.b., N. Y.	unit	4.00		
Bone, 3 and 50, ground, raw	ton	30.00	—	32.00
Fish scrap, dom., dried, f.o.b. works	unit	3.10	—	3.20
Nitrate soda	100 lb.	2.37	—	2.40
Tankage, high grade, f.o.b. Chicago	unit	3.25	—	3.40
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%	ton	5.50	—	7.00
Tennessee, 78-80%	ton	8.50	—	9.00
Potassium muriate, 80%	ton	34.00	—	37.00
Potassium sulphate	unit	1.00	—	.....

Crude Rubber

Quotations Unchanged as of Feb. 8.

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.10½	—	$0.10¾
Castor oil, AA, in bbls.	lb.	.11½	—	.12
China wood oil, in bbls.	lb.	.14½	—	.14¾
Coconut oil, Ceylon grade, in bbls.	lb.	.08½	—	.09
Coconut oil, Cochin grade, in bbls.	lb.	.09½	—	.10
Corn oil, crude, in bbls.	lb.	.08½	—	.09
Cottonseed oil, crude (f. o. b. mill)	lb.	.08¼	—	.08¾
Cottonseed oil, summer yellow	lb.	.09½	—	.10
Cottonseed oil, winter yellow	lb.	.10¼	—	.10¾
Linseed oil, raw, car lots (domestic)	gal.	.86	—	.87
Linseed oil, raw, tank cars (domestic)	gal.	.82	—	.83
Linseed oil, in 5-bbl lots (domestic)	gal.	.90	—	.91
Olive oil, denatured	gal.	1.10	—	1.12
Palm, Lagos	lb.	.08	—	.08¼
Palm, Niger	lb.	.06½	—	.06¾
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.08¼	—	.08¾
Peanut oil, refined, in bbls.	lb.	.11	—	.11½
Rapeseed oil, refined in bbls.	gal.	.84	—	.85
Rapeseed oil, blown, in bbls.	gal.	.88	—	.89
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.09	—	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.07	—	....

FISH

Light pressed menhaden	gal.	$0.48	—	....
Yellow bleached menhaden	gal.	.51	—	....
White bleached menhaden	gal.	.50	—	....
Blown menhaden	gal.	.57	—	....

Miscellaneous Materials

Prices Remain the Same as Feb. 8 Report

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	per 1,000	$130.00
Carborundum refractory brick, 9-in.	1,000	1100.00
Chrome brick, f.o.b. Eastern shipping points	net ton	41–44
Chrome cement, 40-50% Cr_2O_3	net ton	30–32
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton	30–32
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	32–37
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	27–30
Magnesite brick, 9-in. straight (f.o.b. works)	net ton	53–55
Magnesite brick, 9-in. arches, wedges and keys	net ton	70
Magnesite brick, soaps and splits	net ton	90
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	35–37
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	37–39
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.	1,000	27–30

Ferro-Alloys

All f.o.b. Works

Ferrocarbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	—	$225.00
Ferrochromium, per lb. of Cr contained, 6-8% carbon, carlots	lb.	.11½	—	....
Ferrochromium, per lb. of Cr contained, 4-6% carbon, carlots	lb.	.12	—	....
Ferromanganese, 76-80% Mn, domestic	gross ton	59.00	—	60.00
Ferromanganese, 78-82% Mn, English and German c.i.f. Atlantic seaport	gross ton	58.00	—	62.50
Spiegeleisen, 18-22% Mn	gross ton	25.00	—	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.25	—	.....
Ferrosilicon, 10-15%	gross ton	38.00	—	40.00
Ferrosilicon, 50%	gross ton	54.00	—	55.00
Ferrosilicon, 75%	gross ton	115.00	—	120.40
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.40	—	.50
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	6.00	—	.....
Ferrovanadium, 30-40% per lb. of contained V.	lb.	4.00	—	4.25

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	$6.00	—	$12.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	ton	21.00	—	22.00
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	ton	20.00	—	21.00
Coke, foundry, f.o.b. ovens	net ton	3.75	—	4.25
Coke, furnace, f.o.b. ovens	net ton	2.85	—	3.00
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	12.00	—	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00	—	22.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½	—	.01¾
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.24	—	.....
Manganese ore, chemical (MnO_2)	net ton	55.00	—	60.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.48	—	.50
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	27.00	—	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12	—	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.13	—	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.	unit	.11	—	.12
Rutile, 95% TiO_2 per lb. ore	lb.	.12	—	.....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	2.50	—	2.75
Tungsten, wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	2.75	—	3.00
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.25	—	1.75
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25	—	2.50
Vanadium pentoxide, 99%	lb.	12.00	—	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00	—	.....
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04½	—	.13½

Non-Ferrous Metals

New York Markets

		Cents per Lb.
Copper, electrolytic		13.125–13.25
Aluminum, 98 to 99 per cent		19.00
Antimony, wholesale lots, Chinese and Japanese		4.45
Nickel, ordinary (ingot)		41.00
Nickel, electrolytic		44.00
Nickel, electrolytic, resale		32.00
Monel metal, shot and blocks		35.00
Monel metal, ingots		38.00
Monel metal, sheet bars		40.00
Tin, 5-ton lots, Straits		30.375
Lead, New York, spot		4.70
Lead, E. St. Louis, spot		4.375–4.40
Zinc, spot, New York		4.925–4.95
Zinc, spot, E. St. Louis		4.475–4.50

OTHER METALS

Silver (commercial)	oz.	$0.66¾
Cadmium	lb.	1.00–1.10
Bismuth (500 lb. lots)	lb.	2.00@2.10
Cobalt	lb.	3.00@3.25
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	85.00@ 90.00
Iridium	oz.	170.00@190.00
Palladium	oz.	55.00@ 60.00
Mercury	75 lb.	48.00

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

BIRMINGHAM—V. L. Smith, 208 North 54th St., and associates are organizing a new company to construct and operate an oil-refining plant in this vicinity, with reclaiming department for byproducts manufacture. Plans will be prepared at an early date.

BESSEMER—The W. L. Lemly Foundry Co. is planning for enlargements and improvements in its plant. The company recently acquired the Columbus Foundry Co., Columbus, Ga., and its plant will be removed to the Bessemer site.

California

LONG BEACH—Hancock Bros., 620 East Anaheim Ave., operating a local metal works, are planning for the erection of a 2-story addition, 50 x 60 ft., to be equipped as an enameling and electroplating plant. The new building will adjoin the present plant structures.

FILLMORE—The California Asbestos & Kieselguhr Co., Los Angeles, recently incorporated with a capital of $1,000,000, is planning for the erection of a new plant in the vicinity of Fillmore for the manufacture of mineral insulation products. The company is headed by O. P. Posey, Pasadena, Cal.

LOS ANGELES—The Los Angeles Fertilizer Co. has awarded a contract to the Ralph E. Homann Co., 3720 South Park Ave., for the erection of a new 1-story building at 2643 Edwin St., 45 x 100 ft.

Connecticut

WALLINGFORD—The Wallingford Steel Co., recently organized with a capital of $200,000, is perfecting plans for the erection of its proposed new steel works on property acquired at the terminus of Valley St., to comprise three 1-story buildings, 100 x 130 ft., 50 x 110 ft. and 25 x 100 ft., respectively. F. A. Wallace and C. W. Leavenworth, both of Wallingford, head the company.

Delaware

LEWES—The Lewes Fertilizer Co. has awarded a contract to the Austin Co., Bulletin Bldg., Philadelphia, Pa., for the erection of a new 1-story plant, estimated to cost about $65,000. Work will be commenced at once.

Florida

CLERMONT—The Board of Trade is perfecting plans for the organization of a new local company to operate a glass-manufacturing plant, and has selected a site for the erection of a 1-story plant, 150 x 200 ft., to be equipped for the production of bottles, preserving jars, etc. The machinery is estimated to cost about $20,000.

Illinois

CHICAGO—The National Card, Mat & Board Co., 218 West Superior St., manufacturer of cardboard, paper products, etc., has awarded a contract to the Holton Seelye & Co., 140 South Dearborn St., for the erection of a 1-story plant at 4318-36 Carroll Ave., 100 x 140 ft., estimated to cost about $35,000. C. H. Crysler is president.

Indiana

MARION—The Indiana Fiber Co. has work under way on a number of extensions and improvements in its plant to double, approximately, the present capacity.

EDINBURG—The Union Starch & Refining Co. is considering tentative plans for the establishment of a soy bean oil-extraction plant in connection with its present works. A byproducts extension will also be erected.

Kansas

HUTCHINSON—The Carey Fiber Products Co., is planning for the rebuilding of the portion of its plant, destroyed by fire, Feb. 1, with loss estimated to be in the neighborhood of $35,000.

Kentucky

PAINTSVILLE—The Big Sandy Refining Co., recently organized, is planning for the erection of a new oil refinery on local site, with initial capacity of about 100 bbl. per day. The plant will utilize crude oil from the Berea field, Johnson County. Ralph Stafford is president; and Earl Stafford, secretary and treasurer.

Maryland

BALTIMORE—The Commercial Chemical Co. has leased space in the building at 23 Light St., and will establish a plant for the manufacture of denatured alcohol products and derivitives. Edward S. Tyler is president.

BALTIMORE—The American Concrete Tile & Products Co., 305 Gaither Bldg., will take bids early in March for the erection of its proposed new local plant, to be 1-story, 60 x 200 ft., and estimated to cost about $70,000, including equipment. John E. Springer is president, and John W. Ritter, secretary and treasurer.

BALTIMORE—The White Co., 206 Water St., manufacturer of paints and varnishes, is planning for the erection of a new 3-story plant, to be equipped primarily for the manufacture of paint products. It is proposed to commence construction at an early date. C. M. Stengle is president.

HAVRE DE GRACE—Norman Marritt and associates have acquired the property of the Maryland Flint & Feldspar Co., at Kalmia, near Havre de Grace, and plan for extensive operations.

BALTIMORE—Hynson, Westcott & Dunning, Charles and Franklin Sts., manufacturers of drugs, chemicals, compounds, etc., have awarded a contract to Hicks, Tase & Norris, 106 West Madison St., for the erection of a new 3-story plant, 50 x 150 ft., estimated to cost about $175,000, including equipment. Howard Sill, 11 East Pleasant St., is architect.

Massachusetts

CANTON—The George Grow Tire Co., 323 Columbus Ave., Boston, Mass., has awarded a contract to Coleman Bros., 49 Medford St., Charlestown, Mass., for the erection of a new addition to its rubber factory on Jackson St., Canton, 40 x 100 ft., estimated to cost close to $60,000. Work will be commenced at once.

Michigan

ESCANABA—B. C. Chatfield, Escanaba, is organizing a company to construct and operate a new local foundry for the manufacture of iron, brass and other metal castings. It will be located in the Iron Mountain district. Plans will be prepared at an early date.

Missouri

LEEDS—The Wilson Slaughtering Device Co., 511 American Bank Bldg., Kansas City, Mo., has commenced excavations for a new plant near Leeds, to be equipped for the manufacture of serums. It will consist of four units, each about 30 x 40 ft., and is estimated to cost about $50,000.

New York

BROOKLYN—The Perfect Brick & Hollow Tile Co., care of Silverman & Infanger, architects, 188 Montague St., is taking bids for the erection of its proposed new 1-story plant, 100 x 100 ft., on Grand St., estimated to cost about $50,000.

NEW YORK—The Fleischmann Co., 701 Washington St., manufacturer of yeast, has taken title to property on Mott Ave. near 157th St., 210 x 257 ft., for a consideration said to be $125,000, and will use the site for its proposed new 3-story laboratory building, 52 x 165 ft., estimated to cost about $250,000, instead of $150,000, as previously announced. Contract for erection has been let to the George A. Fuller Co., Flatiron Bldg., New York.

NEW YORK—Fire, Feb. 10, destroyed a portion of the plant of the Goldberger Plate Glass Co., 457-61 First Ave., with loss estimated at about $75,000.

POUGHKEEPSIE—The Corrugated Rubber Co., care of W. J. Beardsley, architect, 49 Market St., Poughkeepsie, is completing plans and will soon take bids for the erection of a new plant in the Fairview section, to be 1-story, 60 x 200 ft., and estimated to cost about $90,000.

NORTH TONAWANDA—The Board of City Commissioners will have plans prepared at once for a new filtration plant at the city waterworks, to cost about $250,000, including equipment. J. N. Chester, Pittsburgh, Pa., is engineer. The Board of Public Works is in charge.

Oklahoma

MUSKOGEE—The Muskogee Oil Refining Co., South Cherokee St., is planning for extensions and improvements in its oil-refining plant to cost about $200,000, including equipment.

Pennsylvania

PHILADELPHIA—The Bath Portland Cement Co., Finance Bldg., has completed plans and will call for bids immediately for the erection of a new cement-manufacturing plant at Sandts Eddy, Pa., utilizing a site acquired by the company a number of months ago. The plant will comprise a number of buildings and is estimated to cost about $1,750,000, including machinery. It will be electrically operated in all departments. The company has arranged a fund of $300,000 for extensions and improvements to its mill at Bath, Pa., including the complete electrification of this works. Louis Rafetto is president; and P. H. Hahneman, treasurer.

PHILADELPHIA — The Pennsylvania Synthetic Gas & Chemical Co., Witherspoon Bldg., has leased space in the building at Broad and Spring Garden Sts., for a local works.

LOCH HAVEN—The Queens Run Refractories Co., Inc., has been organized to take over and consolidate the Queens Run Fire Brick Co., North Bend Fire Brick Co. and the West Branch Fire Brick Co. The new organization will continue the operation of the different plants, and has plans under consideration for expansion. William Sleicher is president, and John F. Marshall, secretary.

Tennessee

JOHNSON CITY—The Crab Tree Corporation, Johnson City, is planning for extensive operations on feldspar, mica and kaolin properties in Mitchell and Yancey Counties, N. C. The company has a tract of about 2,500 acres of land and will erect a new grinding mill and other plant buildings. Equipment to cost in excess of $150,000, a portion of which has been ordered, will be installed. A housing development for operatives will also be established. Frank R. Scott is president.

Texas

MEXIA—The Humphreys-Pure Oil Co. is perfecting plans for the erection of its proposed new refinery at Port Neches, Tex., and plans to commence work early in the spring. It will have an initial capacity of about 40,000 bbl. of crude oil per day. A pipe line will be constructed from the Mexia fields to the plant. The refinery will cost close to $1,000,000. Col. E. A. Humphreys is president. The company is erecting a 3-story office building on Belknap St., Mexia.

SNYDER—Smith & Hamer, Snyder, have acquired a local site and plan for the immediate erection of a new leather tannery.

Utah

PARK CITY—The Silver King Coalition Co. has construction under way on a new concentrating plant and proposes to begin operations late in March. The machinery installation has been commenced.

Virginia

NORFOLK — The Robertson Chemical Corp. is planning for the rebuilding of its plant unit, recently destroyed by fire. Walter H. Roberston is president.

West Virginia

PARKERSBURG—Fire, Feb. 2, destroyed the local branch plant of the Biddle Concrete Co., Clarksburg, W. Va., manufacturer of sewer pipe, blocks, etc., with loss estimated at about $30,000, including equipment. John C. Biddle is general manager.

New Companies

THE DODGE CHEMICAL CO., Boston, Mass., has been incorporated with a capital of $50,000, to manufacture chemicals and chemical byproducts. Albert N. Lockhart is president; and C. F. Dodge, 20 Weban St., Boston, treasurer.

THE AMERICAN CELLO GLASS CO., New York, N. Y., has been incorporated with a capital of $100,000, to manufacture paper products, artificial silk and kindred specialties. The incorporators are R. Harris, T. T. Curran and C. W. Mitchell, 2 Rector St., New York.

THE JOHNSTON PAINT & GLASS CO., 8727 Grand River Ave., Detroit, Mich., has been incorporated with a capital of $25,000, to manufacture paints, oils, varnishes, etc. The incorporators are R. Fee Johnston, William C. and John L. Shepard.

THE GRANT CHEMICAL CO., Newark, N. J., has been incorporated with a capital of $25,000, to manufacture chemicals and chemical byproducts. The incorporators are Nathan Gelb, William M. and Lovett A. Grant, 790 Broad St., Newark.

JAMES C. DEERY, INC., New York, N. Y., has been incorporated with a capital of $10,000, to manufacture pulp products. The incorporators are J. C. and L. E. Deery, and J. A. F. Newton. The company is represented by A. Warshow, 464 Broome St., New York.

JEFFERY & SON LUBRICANTS CO., Greenleaf and Hartrey Aves., Evanston, Ill., has been incorporated with a capital of $500,000, to manufacture lubricating oils. The incorporators are E. R. and W. O. Jeffery, Sr. and Jr.

SAMUEL KIDDER & CO., INC., Boston, Mass., has been incorporated with a capital of $27,000, to manufacture chemicals and chemical compounds. George A. Spear is president; and George P. Nason, Medford, Mass., treasurer.

THE PENN-BEDFORD OIL CO., Johnstown, Pa., has been incorporated with a capital of $100,000, to manufacture petroleum products. Thomas H. Watt, Johnstown, is treasurer.

LEVIN & CO., INC., San Antonio, Tex., has been incorporated with a capital of $10,000, to manufacture greases, lubricants, etc. The incorporators are William Levin and W. P. Gee, both of San Antonio.

THE CHEMICAL INK CO., Brooklyn, N. Y., has been incorporated with a capital of $100,000, to manufacture chemicals, inks and affiliated products. The incorporators are J. A. Seixas, K. Dyer and W. H. Stieglitz. The company is represented by M. J. Moore, 141 Broadway, New York.

THE CHOLORO CHEMICAL CORP., New York, N. Y., has been incorporated under Delaware laws with capital of $200,000, to manufacture chemicals and chemical byproducts. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE BIRMINGHAM METAL CO., 231 South Exeter St., Baltimore, Md., has been incorporated with a capital of $200,000, to operate a metal-refining plant and ore-reduction works. The incorporators are Charles H. Birmingham, Joseph C. Rintelen and John P. Simon.

THE S. L. AGOOS TANNING CO., INC., Boston, Mass., has been incorporated with a capital of $75,000, to manufacture leather. Samuel L. Agoos, 60 Amory St. Brookline, Mass., is president and treasurer; Norman D. Nepon is vice-president.

THE ESTATE OF JAMES R. SAYRE, JR., INC., Newark, N. J., has been incorporated with a capital of $728,000, to manufacture bricks and other burned clay products. The incorporators are M. H. Barker, E. M. Burbank and H. T. Brooks. The company is represented by Edward M. and Runyon Colie, 763 Broad St., Newark.

THE WESCO PRODUCTS CO., 39 South La Salle St., Chicago, Ill., has been incorporated with a capital of $25,000, to manufacture paints, cement preparations, etc. The incorporators are Thomas H. Maddock, Jacob H. Jaffe and Vincent J. Green.

THE LION OIL & REFINING CO., El Dorado, Ark., has been incorporated with a capital of $150,000, to manufacture refined petroleum products. The incorporators are F. H. Thwing, E. D. Ellison and George A. Todd, El Dorado. The last noted represents the company.

SNELL & PIERCE, INC., Syracuse, N. Y., has been incorporated with a capital of $100,000, to manufacture chemicals and chemical byproducts. The incorporators are A. W. Snell, H. O. Pierce and D. E. Alvord. The company is represented by Alvord & Brewster, attorneys, Syracuse.

THE ARIZON TRIPLE MOUNTAIN COPPER CO., Franklin, Tenn., has been incorporated under Delaware laws with a capital of $5,000,000, to operate a metal-refining plant for copper production. The incorporators are P. V. Channel, Franklin, Tenn.; J. C. Askew and C. F. Matthews, Nashville, Tenn. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington, Del.

THE PLYMOUTH PAPER PRODUCTS CO., Mount Vernon, N. Y., has been incorporated with a capital of $100,000, to manufacture paper goods. The incorporators are L. C. Smith, H. Moak and M. J. White. Holden & Cavanaugh, attorneys, Mount Vernon, represent the company.

THE DETROIT ELECTRO-METALS CO., Detroit, Mich., has been chartered under state laws to manufacture aluminum and other metal products, metal alloys and chemical specialties. The incorporators are Dennis Boyle, Clarence E. Lehr and Thomas F. Murphy, 217 Philip Ave., Detroit.

THE SHELL-UNION OIL CO., New York, has been incorporated under Delaware laws with a capital of $1,000,000, to form a merger between the Union Oil Co. of Delaware, 17 East 42d St., New York, and the Shell Transport & Trading Co., San Francisco, Cal., to operate oil refineries in California and other districts, and manufacture refined petroleum products of various kinds. Headquarters will be at the New York address noted.

THE NIAGARA INK CO., Albany, N. Y., has been incorporated with a capital of $500,000, to manufacture inks and affiliated products. The incorporators are E. W. Ladd, J. B. Condon and T. A. Brown. The company is represented by H. J. Crawford, attorney, Albany.

THE INDUSTRIAL DYESTUFF CO., East Providence, R. I., has been incorporated with a capital of $50,000, to manufacture dyes, chemicals, etc. The incorporators are Herbert L. Tobey, Simon Norman and John H. Caton, Jr., 96 Arnold Ave., Edgewood, R. I.

THE SOUTHWEST PULP & PAPER CO., Wilmington, Del., has been incorporated under state laws with capital of $2,500,000, to manufacture pulp and paper products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE GLOBE PETROLEUM CO., Richmond, Va., has been incorporated with a capital of $5,000,000, to manufacture petroleum products. Sherwood E. Hall is president; and Frederic G. Bastian, secretary, both of Richmond.

THE STERLING-WELD CO., New York, N. Y., has been incorporated with a capital of $5,000, to manufacture aluminum and other metal products. The incorporators are W. H. Sterling, V. A. Whitla and E. F. Degruchy. The company is represented by C. M. Russell, 50 Church St., New York.

THE GOULD FIRE PREVENTION PRODUCTS CO., Wilmington, Del., has been incorporated under state laws with a capital of $500,000, to manufacture fireproof paints and other fire-resisting compounds. The company is represented by the Delaware Charter Co., 904 Market St., Wilmington.

POMEROY & FISHER, INC., New York, N. Y., has been incorporated with a capital of $250,000, to manufacture chemicals, paints and kindred products. The incorporators are A. P. Demarmon, S. Steinkamp and C. B. Grimes. The company is represented by Salter & Steinkamp, 140 Nassau St., New York.

THE BARIUM PRODUCTS CORP., Carbondale, Ill., has been incorporated with a capital of $40,000, to manufacture chemicals and metallurgical specialties. The incorporators are Robert Forsyth, J. H. Mitchell and R. A. Taylor. The company is represented by Herbert A. Hays, Carbondale.

THE RUSSELL CLAY MFG. CO., Wilmington, Del., has been incorporated under state laws with a capital of $600,000, to manufacture ceramic and burned clay products. The company is represented by the Corporation Service Co., Wilmington.

THE RED CIRCLE RUBBER CO., Wilmington, Del., has been incorporated under state laws with capital of $1,000,000, to manufacture automobile tires and tubes, and other rubber products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE MORRIS TANNING CO., Peabody, Mass., has been incorporated with a capital of $100,000, to manufacture leather. Charles D. C. Moore is president; and Abraham Cohen, Beachmont, Mass., treasurer.

THE HAINES SHELLAC WORKS, INC., New York, N. Y., has been incorporated with a capital of $10,000, to manufacture shellac and kindred products. The incorporators are S. J. and J. Haines, and H. Maas. The company is represented by David Sobel, 136 William St., New York.

Capital Increases

THE DETROIT SOLUBLE OIL CO., Detroit, Mich., has filed notice of increase in capital from $50,000 to $150,000.

THE OSWEGO FALLS CORP., Fulton, N. Y., recently incorporated with a capital of $2,500,000, to manufacture pulp and paper products, comprising a merger of a number of mills in this section, has arranged for a bond issue of $2,100,000, for general operations, financing and expansion. H. L. Paddock is president.

LOUIS SACKS, INC., Wilson Ave., Newark, N. J., manufacturer of iron and other metal castings, has filed notice of increase in capital from $500,000 to $600,000.

THE ASBESTOS & MINERAL CORP., 1819 Broadway, New York, N. Y., has filed notice of a reduction in capital from $500,000 to $135,000.

THE RABE PIPE & FOUNDRY CO., Chattanooga, Tenn., has filed notice of increase in capital from $200,000 to $350,000. R. R. Rabe is president.

THE BARCO PETROLEUM CORP., 149 Broadway, New York, N. Y., a Delaware corporation, has filed notice of increase in capital from $3,000,000 to $12,000,000.

THE AJAX ENAMELING & FOUNDRY CO., Battle Creek, Mich., has filed notice of dissolution under state laws.

John S. Dickerson, trustee in bankruptcy for the AMERICAN TIN SMELTERIES, INC., has arranged for the sale of the company's smelting plant at Matawan, N. J.

THE WANDER & SONS CHEMICAL CO., Albany, N. Y., has field a petition in bankruptcy, with liabilities stated at $594,078 and assets $183,588. Frank M. Wright has been appointed receiver.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its twenty-fourth annual meeting at St. Louis, Feb. 27 to March 3, 1922.

AMERICAN CHEMICAL SOCIETY will hold its spring meeting at Birmingham, Ala., April 4 to 7, 1922.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Baltimore, April 27, 28 and 29, 1922. Headquarters will be at the Emerson Hotel.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Rochester, N. Y., during the week of June 5, 1922. Meetings will be held in the spring instead of in the fall as heretofore

AMERICAN SOCIETY FOR STEEL TREATING will hold a sectional meeting, Friday, March 3, at the Hotel McAlpin, New York City. A sectional meeting will also be held at the Bureau of Mines auditorium, Pittsburgh, Pa., on May 25 and 26. The International Steel Exposition and Convention of the society will be held in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

IRON AND STEEL INSTITUTE (British) will hold its annual meeting on May 4 and 5 at the House of the Institution of Civil Engineers, Great George St., S. W., 1, London.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: March 10—American Chemical Society, Nichols Medal; March 24—Society of Chemical Industry, regular meeting; April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.